RMRS Rocky Mountain Remediation Services, L.L.C
. . . protecting the environment

RF/RMRS-99-358.UN

Closeout Radiological Survey Report

For Building 729

Rocky Mountain Remediation Services, L.L.C.

Millennium Services Inc.

Revision 1

July 1999

Volume 1

1/97

CLOSEOUT RADIOLOGICAL SURVEY REPORT
FOR BUILDING 729

REVISION 1

JULY, 99

This Closeout Radiological Survey Report was prepared by:

Michael Grube, Final Survey Radiological Engineer (GTS DURATEK)	8/13/99 Date

This Closeout Radiological Survey Plan has been reviewed and approved by:

Sarah Roberts, Radiological Engineer, B779 (ARCADIA)	8/17/99 Date
Mark Brooks, Quality Assurance Manager (RMRS)	8-17-99 Date
Mark Hickman, Integration Manager, B779 (RMRS)	8-18-99 Date
Jeff Barroso, Deputy Radiological Safety Manager, B779 (RMRS)	8/17/99 Date
Terry Vaughn, Radiological Safety Director (RMRS)	8/19/99 Date
Thomas Dieter, Project Manager, B779 (RMRS)	8/18/99 Date
Brian Mathis, Manager D&D Projects (K-H)	8/23/99 Date

Table of Contents

VOLUME 1

Appendices

VOLUME 2

VOLUME 3

Acronyms

CPM	Counts Per Minute
CRSP	Closeout Radiological Survey Plan
D&D	Decontamination and Decommissioning
$DCGL_W$	Derived Concentration Guideline Level – Wilcoxon Rank Sum test
$DCGL_{EMC}$	Derived Concentration Guideline Level – Elevated Measurement Comparison
DOE	U.S. Department of Energy
DPM	Disintegration Per Minute
DQA	Data Quality Assessment
DQO	Data Quality Objectives
FSS	Final Status Survey
FSSP	Final Status Survey Plan
FSSR	Final Status Survey Report
HSA	Historical Site Assessment
LBGR	Lower Bound or the Gray Region
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
NIST	National Institute of Standards & Technology
NORM	Naturally Occurring Radioactive Material
PRE	Project Radiological Engineer
PSPC	Position Sensitive Proportional Counter
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
RCT	Radiological Control Technician
RE	Radiological Engineer
REFS	Radiological Engineering Field Services
RESS	Radiological Engineering Support Services
RFETS	Rocky Flats Environmental Technology Site
SCM/SIMS	Surface Contamination Monitor/Survey Information Management System
SRA	Shonka Research Associates
TSA (TSC)	Total Surface Activity (or Total Surface Contamination)
V&V	Verification and Validation

Abstract

Building 729 is a former support building to Building 779, a research facility involved in the handling of transuranic materials. Building 729 contained air filtration systems, and emergency power generator. Building 729 is connected to Building 779 by a bridge that contained a ventilation duct leading to the filter plenum. Three survey units were established in Building 729:

- 72901 – Plenum room, stairwell, and bridge (Class 2)
- 72902 – Diesel generator room, control room, hallway (and airlock) and lavatory (Class 3)
- 72903 – Exterior walls and roof (Class 2)

Surface contamination measurements, paint/surface media samples and removable contamination surveys were performed in each survey unit. The number of samples and removable/total surface contamination surveys taken in each area was determined using the MARSSIM statistical approach. Random and systematic locations were established for samples and removable/total surface contamination surveys. Surface scans were performed at the density of:

- Class 2 – 100% floors and wall up to 2 meters, 10% of area above 2 meters (per the Closeout Radiological Survey Plan for the 779 Cluster, the percentage was based on findings on floor and lower walls)
- Class 3 – 10% of surface area

Results of all paint/surface media samples and removable/total surface contamination surveys were all below the Derived Concentration Guideline Levels (DCGLs) established in the survey plan. In Survey Unit 72901, initial surface contamination characterization surveys identified small areas of radioactivity near or above the $DCGL_{EMC}$ (300 dpm/100 cm^2) on the pedestal around the west pit in the plenum room, on the west end of the southwest pedestal, and on the floor and walls of the west pit. All areas were remediated prior to performing final surveys.

The galvanized roof flashing was also found to indicate elevated total activity. Sample coupons were obtained and sent to an on-site laboratory for gross alpha spectroscopy analysis. The analysis identified Polonium-210 (Po-210), a naturally occurring isotope in the uranium – radon decay chain. No transuranic isotopes or uranium isotopes were detected. However, for conservatism, the DCGLs associated with uranium were applied, with all values falling below the applicable DCGL.

6

1.0 Introduction

Building 729 is the first building of the 779 Closure Project at Rocky Flats Environmental Technology Site to undergo preparation for final survey. The building was constructed in 1971 as a support facility to Building 779. Building 779 was used as a Nuclear Weapons Research & Development Center, and contained process equipment, which mimicked some of the production facilities' mission, and laboratory equipment to conduct material and environmental testing.

Building 729 is connected to Building 779 via a second-story bridge and provided operational support for Annex B. Building 729 contained a filter plenum and an emergency electrical power generator. Building 729 dimensions are 72 feet long x 38 feet wide x 18 feet high.

Final status surveys of Building 729 were performed to meet the requirements defined in the Closeout Radiological Survey Plan (CRSP) for the 779 Cluster, RF/RMRS-97-123.UN, Revision 2, March 99. As described in that plan, alpha-emitting radionuclides are considered the primary potential contaminant within Building 729. Alpha-to-beta ratios identified in the characterization efforts for the 779 closure project support justification for performing alpha-only surveys for surface contamination. In addition, as discussed in the CRSP, beta characterization surveys were performed in the filter plenums. Since no beta activity greater than MDA was discovered in the filter plenums, no additional beta surveys were required for B729. The primary alpha emitting radionuclide is Plutonium-239 (93.9% weight fraction), with small amounts of Plutonium-238, Plutonium-240, Plutonium-241, and Americium-241. Plutonium-239 and Plutonium-240 combined account for about 87% of the alpha activity.

Characterization surveys of Building 729 were performed following strip-out of the facility. Final status surveys commenced during the week of February 15, 1999 in the emergency electrical power generator room, control room and portions of the connecting bridge to Building 779, and were completed during the week of April 12, 1999.

1.1 Survey Unit Descriptions

Building 729 consists of a main plenum room, a stairwell to a bridge to building 779, an emergency electric power generator room, a control room, an entrance hall and a toilet room. The construction of the facility is concrete block walls, including all interior walls, on a concrete slab. The exterior walls are constructed on a concrete footer that extends from approximately 30 cm, to more than 60 cm above grade. An exhaust stack stood at the east end of the structure, but was removed on February 28, 1999. Thus, the stack was not within the scope of this survey. Refer to Figure 1 below for an exterior view of building 729. Building 729 (Survey Area A) was subdivided into three survey units; 72901, 72902, and 72903. Each survey area and survey unit for Building 729 is accounted for on Attachment G, 779 Cluster Final Survey Breakdown Structure.

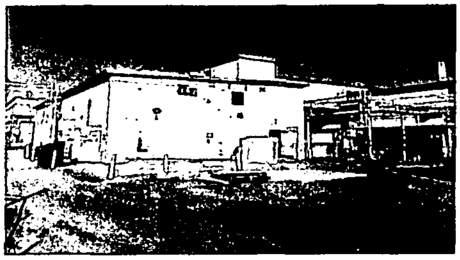


Figure 1 - Exterior of Building 729

Survey Unit 72901, which constitutes the main plenum room, the stairwell and the bridge area, is an Impacted Class 2 Area. Impacted Class 2 Areas are areas that have or had a potential for radioactive contamination or known contamination, but are not expected to exceed the applicable contamination DCGLs. Scan surveys in Class 2 areas were performed such that 100% of the floor and walls up to 2 meters and a minimum of 10% of the area above 2 meters were surveyed. The main plenum room also contained a number of pedestals ranging from 2" to 4" above the slab, and 2 sumps. Edges of the pedestals and the walls and floors of the sumps were included in the 100% survey. All areas of the stairwell leading to the bridge area were surveyed at the density of 100% up to 2 meters, and 10% of the areas above 2 meters. Paint/Surface media samples and removable/total surface contamination surveys were obtained at systematic locations within the plenum room and bridge area. Samples and surveys were obtained in accordance with Survey Package 72901 (refer to Volume 3, Attachment H, Survey Unit 72901 Survey Package).

Survey Unit 72902, which constitutes the diesel generator room, the control room, the entrance hallway (including an airlock), and the lavatory, is an Impacted Class 3 Area. Class 3 Areas are not expected to contain residual contamination or activity at a small fraction of the applicable $DCGL_{WS}$, based on knowledge of building history and previous survey information. However, insufficient documentation is present to exclude the area from survey requirements. Surface Contamination scans in Class 3 Areas included 10% of the total survey unit surface area. Paint/Surface media samples and removable/total surface contamination surveys were obtained at random locations. Samples and surveys were obtained in accordance with Survey Package 72902 (refer to Volume 3, Attachment I, Survey Unit 72902 Survey Package).

Survey Unit 72903, which is comprised of the surfaces exterior to building 729, is an Impacted Class 2 Area, thus 100% surface contamination scans were performed up to 2 meters. 10% of the surfaces above 2 meters, including the exterior surfaces of the connecting bridge between 779 and 729 was scanned. Scans of the exterior walls were performed to a level of 180 cm above the concrete footer. 100% of the concrete footer was also scanned. The height of the footer ranges from 20 cm on the west end to 65 cm above grade on the east end of building 729. Paint/Surface media samples and removable/total contamination surveys were also obtained at systematic locations on the external surfaces of the building. Samples and surveys were obtained in accordance with Survey Package 72903 (refer to Volume 3, Attachment J, Survey Unit 72903 Survey Package).

8

Scope of Work

1.2.1 Paint/Surface Media Samples

Paint/surface media samples were obtained to ensure contamination above the Building 729 DCGLs did not exist below painted surfaces or other forms of surface media such as roofing material, floor adhesive, or within the paint or roofing/adhesive material itself. Due to the fact that there was no evidence (as discovered during the historical site assessment, characterization, and final status surveys) that contamination had migrated into cinder block, concrete, or any other base material and disappeared from the surface, total surface activity measurements and surface media sampling were utilized as the detection methods for any contamination that occurred on building surfaces, and no volumetric samples were collected.

The sample collection method for coated surfaces (paint or adhesive) involved the collection of cover material to a depth where the underlying base material was exposed. For roofs, samples of all layers of base tar material under the ballast layer were collected.

The quantity of samples was determined based on MARSSIM statistical calculations to satisfy Impacted Class 2 and Impacted Class 3 survey requirements. The calculation methodology for the number of media samples is presented in the Closeout Radiological Survey Plan for the 779 Cluster (section 5.2.6.2). Based on the calculations, 15 paint/surface media samples were required for each survey unit. Calculations to determine the minimum number of media samples are included in the survey packages (Volume 3, Attachments H, I, and J).

Instrument calibration, maintenance, source check requirements, as well as data reduction and MDC equations are controlled per applicable Analytical Services Division procedures.

1.2.2 Removable Surface Contamination

Removable surface contamination surveys were obtained to ensure removable contamination did not exist above the Building 779 Cluster DCGLs. The quantity of removable contamination measurements was determined based on MARSSIM statistical calculations as presented in the Closeout Radiological Survey Plan for the 779 Cluster (Section 5.2.6.2). Based on calculations, 17 removable contamination measurements were required for each survey unit. Calculations to determine the minimum quantity of removable contamination measurements are included in the survey packages (Vol. 3, Attachments H, I, & J).

Smears were counted on a Tennelec or SAC-4. Instrument calibration, maintenance, source check requirements, as well as data reduction and MDC equations are provided in 3-PRO-112-RSP-02.01, Revision 1, "Radiological Instrumentation".

1.2.3 Total Surface Activity

The SCM/SIMS system was credited only for the scan surveys obtained in order to prove compliance with the applicable $DCGL_{EMC}$. The SCM/SIMS system data is not applicable to the $DCGL_W$. In addition, investigations were not performed at 75% of the $DCGL_W$, based on SCM/SIMS data.

Total surface activity surveys were obtained to ensure total activity did not exist above the Building 779 Cluster DCGLs. The number of total surface activity surveys was also determined based on MARSSIM statistical calculations as presented in the Closeout Radiological Survey Plan for the 779 Cluster (Section 5.2.6.2). Based on the calculations, 15 total surface activity measurements were required for each survey unit. Calculations to determine the minimum number of total surface activity measurements are included in the survey packages (Volume 3, Attachments H, I, and J).

The surveys were performed with a NE Electra. The survey count time was one-minute. Local area background determinations are discussed in section 3.0. Instrument calibration, maintenance, source check requirements, as well as data reduction and MDC equations are provided in 3-PRO-112-RSP-02.01, Rev 1, "Radiological Instrumentation".

1.2.4 Surface Scan Surveys

Surface scan surveys were conducted using the Surface Contamination Monitor/Survey Information Management System (SCM/SIMS) developed by Shonka Research Associates, Inc. (SRA). The system consists of a position sensitive proportional counter (PSPC) coupled to a computerized data acquisition system. The PSPC is a long detector that acts as an array of many small radiation detectors. This allows the instrument to measure more area per unit time than a smaller detector and still separate out localized areas of contamination. The PSPC is mounted to a motor driven cart. The drive motor provides speed control for the unit, and a precision wheel encoder, affixed to the cart, provides travel distance input to the computer. Counts are accumulated in each 5 cm. channel every 5 cm. travel by the system. The result is data retained in 5 cm. x 5 cm. (25 cm^2) pixels, available for analysis and presentation via the SIMS software. Surveys were conducted at a speed of 2.5 cm/sec (approximately 1 inch/sec.). A recount detector was employed for all surveys performed with the cart-mounted detectors. Recount detectors perform a second survey of the area surveyed by the primary detector. The main purpose of the recount detector is to reduce the number of false positive results due to the low $DCGL_W$ for alpha emitting isotopes, and the low and variable background. A few background counts occurring in a small area can result in an indication of elevated activity. The probability of background affecting both the primary and the recount detector is greatly reduced, thus reducing the need to perform verification surveys.

Detector surface areas were 700 cm^2 and 1800 cm^2. Choice of detector was based on the floor space available and the interferences in the area. To complete surveys in areas that were not accessible with the standard cart mounted detectors, corner detectors were employed. The corner detector is a similar PSPC used in a static count mode with data binned in 5 cm. increments. The corner detector accumulates data for eight seconds. The longer count time eliminated the need for recount. The output of the corner detector was formatted to allow integration into the SIMS software to complete the survey data for a survey area.

Wall surveys were performed by mounting the detectors vertically to the side of the SCM cart. All other aspects of the survey were consistent with floor monitoring. The drive wheel maintained speed control, and position sensitivity was established through the wheel encoder and the height above grade as identified by the PSPC.

Surveys were conducted in accordance with equipment operation and calibration procedures developed by SRA and incorporated in the Millennium Services, Inc. Quality Assurance Plan. Detector efficiencies were determined with a NIST traceable Plutonium-238 source with an active area of approximately 50 cm^2 and an alpha energy of 5.5 Mev. The energy of the source is similar to the 5.1 Mev of Plutonium-239, the principle isotope of the primary suspected contaminant. Periodic Quality Control checks were performed for each detector in use, and used to establish the efficiency for the detectors based on data that spanned the use of that detector during the survey (See section 4). All quality control checks were performed under the same operating and environmental conditions as the surveys.

MARSSIM calculations for the total number of measurements per survey unit were performed, and Electra measurements were obtained at the specified survey density to achieve compliance with the applicable $DCGL_W$ for total surface contamination. The SCM/SIMS system data is not applicable to the $DCGL_W$. The use of the SCM/SIMS system for total surface activity measurements in order to ensure compliance with the $DCGL_W$ for the remaining buildings in the 779 Cluster is pending final approval by Kaiser Hill.

2.0 DCGLs

The surface contamination criteria from DOE Order 5400.5 were used as the DCGLs for the final survey. The applicable transuranic $DCGL_W$ for removable contamination, and total surface activity measured by direct surface emission are as follows:

Removable Alpha	$DCGL_W$ Total Alpha	$DCGL_{EMC}$ Total Alpha
20 dpm/100 cm^2	100 dpm/100 cm^2	300 dpm/100 cm^2

The applicable transuranic $DCGL_w$ for paint/solid media samples is 100 dpm/100 cm^2.

The applicable uranium $DCGL_w$ for paint/solid media samples and total surface activity attributable to uranium, and verified by isotopic analysis is 5000 dpm/100 cm^2.

3.0 Background

Final radiological surveys of building 729 were focussed on alpha emitting isotopes, principally Plutonium-239, and Plutonium-240. Natural activity present in construction materials was not expected to contribute a significant amount to the field measurements. Historical data from other RFETS building indicates that surface emission rates from concrete, typically the material containing the highest quantities of naturally-occurring alpha-emitting isotopes, would have contributed a range of 10 to 20 dpm/100 cm^2 on an average. Therefore, surface scan measurements evaluated the gross activity values against the DCGL's defined in section 2.0. This approach resulted in a conservative evaluation of potential contamination due to previous operations associated with building 729.

Instrument background was considered as the only source of background counts to the SCM during surface scan surveys. Inherent instrument background determination is discussed in Appendix 4. The instrument background for a 180 cm. x 10 cm. detector was determined to be 12.2 counts per minute (cpm), which resulted in a 100cm^2 area background of 0.677 cpm. The instrument background for a 90 cm. x 10-cm. detector was determined to be 8.0 cpm, which resulted in a 100 cm^2 area background was 0.941 cpm. These low values indicated that the instrument background had an insignificant impact on the SCM ability to detect low activity levels. Instrument sensitivity is discussed in Appendix 4.

For total surface activity data collected with the NE Electra, an average one-minute local area background was determined and subtracted from total surface activity measurements to obtain net total surface activity results.

Paint/Surface media samples were analyzed by alpha spectroscopy methods. Individual isotopic data is contained in Volume 3, Attachments H-J. Transuranic isotopes are not present in natural radioactivity, therefore no background concerns exist. Uranium isotopes, though present in nature, are not expected to exist in significant quantities in paint /surface media samples. As in surface activity measurements, total reported activity from paint/surface media sample analyses was evaluated against the applicable uranium or transuranic $DCGL_W$ defined in Section 2.0.

Other than instrument background, which is quantified prior to analysis, background is not a factor during performance of removable contamination surveys. Reported values from the removable contamination surveys were evaluated against the applicable DCGL defined in section 2.0.

4.0 Quality Assurance/Quality Control

Quality control for each type of instrument utilized in the Building 729 survey is discussed in the sections below. As recommended by MARSSIM, a data quality assessment (DQA) was also performed and documented (refer to Appendix 4).

4.1 Scan Surveys

Quality control surveys for scans were performed with a NIST traceable Plutonium-238 source with an activity of 194400 dpm, which was obtained from the source storage area at RFETS. The source, RFETS ID# RS3911, Manufacturer's ID ER716, is a 71 mm x 71 mm (approximately 50 cm^2) plated source. The source manufacturer's certificate is included in Volume 3, Attachment E, Source Certificate-NIST Traceability. Quality control surveys consisted of a minimum of three measurements of the source by the detector in the configuration used in the actual survey. SCM quality control surveys were performed with the source on the floor or wall and the detector assembly moving at the appropriate survey speed (i.e., 2.5 cm/sec). Corner detector quality control surveys consisted of measurements of the source placed on a surface and the data acquisition set for the survey time (i.e., 8 seconds).

A quality control survey was performed at the beginning and end of each detector use each day and periodically during the surveys. The response of the detector over the duration of its use became the basis for the detector's efficiency. Additionally, each survey was evaluated to ensure that it was bracketed by acceptable quality control surveys. When a quality control survey value was within 20% of the mean of all quality control surveys for each specific detector, the detector results were considered valid.

Source checks were conducted daily prior to start of survey, whenever the detector configuration is changed, and whenever any other electronic adjustments or maintenance was performed. The mean of the valid quality control surveys, determined from all acceptable results over the duration of the survey, is used to establish the efficiency for a specific detector. Appendix 2 includes the quality control charts for all detectors used during the survey.

4.2 Total Surface Activity Surveys

An additional 5% of total surface activity measurements were obtained for quality control purposes (refer to Volume 3, Attachments H-J). The results from these measurements were compared to the applicable $DCGL_W$ to ensure survey compliance (i.e., all QC measurements were less than $DCGL_W$). All QC measurements were less than $DCGL_W$ (see Volume 2, Attachments A, B, and C).

4.3 Removable Surface Contamination

The instruments utilized for removable surface contamination analysis (Eberline SAC-4 and Oxford Tennelec) were calibrated with NIST-traceable sources. A daily background and QC check was also performed. All background and QC checks were valid.

4.4 Paint/Surface Media Samples

Quality control for media samples was performed per the applicable laboratory procedures. Measures of laboratory precision and accuracy were assessed per applicable laboratory procedures. All results indicated that sample results were valid (see Volume 3, Attachments H, I, and J).

5.0 Survey Results

5.1 Paint/Surface Media Samples

Paint/surface media samples were obtained at each grid location where paint/surface media existed, ensuring that the minimum required paint/surface media samples were obtained for each survey unit. Volume 2, Attachments A, B and C, present results and a data summary of paint/surface media sample analyses for each survey unit. Alpha spectroscopy was performed to determine the activity of Uranium-233/234, Uranium-235, Uranium-238, Plutonium-239/240, and Americium-241. Values for each isotope(s) is presented separately. All reported values for the three survey units were below the applicable total uranium and total transuranic $DCGL_W$. Copies of data provided by Sanford Cohen & Associates, Inc. are provided in Volume 3, Attachments H, I, and J. The number of media samples obtained was verified to be adequate by re-calculating the required number of samples with the actual survey unit sample standard deviation (refer to Volume 2, Attachments A, B and C).

5.2 Removable Surface Contamination Surveys

Removable contamination measurements were obtained at each accessible grid location. The minimum required removable contamination measurements were obtained for each survey unit. Removable contamination survey results are presented by survey unit in Volume 2, Attachments A, B and C. Surveys were performed at each location from which paint/surface media samples were obtained, ensuring that the minimum required number of smears was collected for each survey unit. For those points, measurements were obtained prior to and after the media sample. For those areas from which no paint/media sample was obtained, a single removable contamination measurement was obtained. The results of all samples show that the removable contamination levels met the applicable $DCGL_W$ described in Section 2.0. The number of removable activity measurements obtained was verified to be adequate by re-calculating the required number of measurements with the actual survey unit measurement standard deviation (refer to Volume 2, Attachments A, B and C).

5.3 Total Surface Activity Surveys

Total surface activity measurements were obtained at each accessible grid location, ensuring that the minimum required total surface activity measurements were obtained for each survey unit. Total surface activity survey results for each survey unit are presented in Volume 2, Attachments A, B and C. Total surface activity surveys were performed at each location where paint/surface media samples were obtained. For those areas where no media sample was obtained, a single total surface activity measurement was obtained (Volume 3, Attachments H, I, J). The results of all surveys showed that all total surface activity levels were less than the applicable $DCGL_W$ described in Section 2.0. The number of total surface activity measurements obtained was verified to be adequate by re-calculating the required number of measurements with the actual survey unit measurement standard deviation (refer to Volume 2, Attachments A, B and C).

5.4 Scan Surveys

Scan contamination survey results are presented in Volume 2, Attachment D. Survey results are grouped by survey unit. For each individual survey SIMS automatically generates a sub-unit report. Appendix 1, SCM/SIMS Scan Survey Overlay Maps, displays the sub-unit survey area locations relative to the survey unit boundaries. Each surveyed area (colored in green or gray to distinguish between areas) is annotated with the corresponding sub-unit number. The required scan frequency for each survey unit, per the Closeout Radiological Survey Plan for the 779 Cluster, was verified.

Each auto-generated sub-unit report consists of several pages. The first three sections of the sub-unit report (i.e., INTRODUCTION, SURFACE ACTIVITY LEVELS, AND SQUARE METER DATA sections) presents the survey name, technician name, date of survey, instrument identification and efficiency, and ranges of measured data for each pixel (25 cm^2) and 100 cm^2 area. The survey names are alpha numeric. The first five characters define the building and the survey unit, (e.g. 72901 is building 729 survey unit 1). The remaining characters are sequential, identifying the survey sub-unit within the survey unit as monitored by SCM/SIMS. Identifiers such as n, e, s, or w are typically used to denote areas such as north walls, east walls, etc.

Figures 1 and 2 of the sub-unit report present a three-dimensional display of the data, and a two dimensional color graphic display. Each of these displays provides spatial information of the radioactivity measured in a survey area. As a result of programming problems, the two-dimensional graphical representations (figure 2) do not all have scales printed out. The omission of these scales does not impact the quality of data or the ability to interpret the results.

Table 1 of the sub-unit report presents a spread sheet evaluation of each square meter area for that survey area. The x,y values for each meter are determined from the two dimension display with the origin in the lower left corner. Therefore meter 1,1 is the square meter in the lower left corner of the two dimensional display. Data presented is the maximum, mean and minimum 100 cm^2 area measured for the square meter area, the standard deviation of the data within that square meter, and the number of 100 cm^2 areas in that square meter. The "100 cm^2 Areas" column indicates the number of 100 cm^2 areas in the square meter that have data. Full square meters will contain one hundred 100 cm^2 areas. Areas that are along the edge of a survey area, have portions of the surface missing (windows, doors, etc.) will show less than one hundred 100 cm^2 areas. The mean values in these areas are averaged over the surveyed area, which is not necessarily a full square meter. Surveys that consist of a series of long thin strips, such as the edges of the concrete pedestal in the main plenum room, are portrayed with the long sides adjacent, rather than end to end, so that analysis of the average square meter data can be performed.

In some cases, the number of 100cm^2 areas listed in the "100cm^2 Areas" column of the auto-generated reports was zero. This phenomenon can occur for several reasons. First, the empty grid may have been contiguous to a surveyed grid, and therefore not surveyed.

15

For example, the database reports data for rectangular areas, but the survey within the rectangle may have actually been L-shaped. The grids contiguous to the L-shaped area will report zero $100cm^2$ areas. Second, a small part of the detector may have been included in the grid, but the geometry was insufficient to contain a square $100cm^2$ area. This second phenomenon also explains why the number of $100cm^2$ areas equaled zero, yet radiological data was reported in the mean, maximum, minimum, and standard deviation columns. The radiological data values are likely to be zero or very low when this occurs (the maximum is the only parameter that may result in a typical value).

The "Comparison of Results with Guidelines" section of the sub-unit report compares the maximum and average scan data against the specific DCGL and identifies those square meter areas that exceed the $DCGL_W$, if any. Figure 3 is included only for those surveys that have 100 cm^2 areas or square meter averages that exceed the applicable DCGL defined in section 2.0. Specific areas exceeding those DCGLs are identified on a two-dimensional display. If all measured values are less than the DCGLs, Figure 3 is not included.

Surveys performed with the SCM used in the encoder mode (moving at 2.5 cm/sec.) will generate a separate report for the primary and recount detector. For this case, the report name will be the same. The detector generating the survey information is indicated at the bottom of each page. Due to the low expected count rate and the random nature of radioactivity, a low occurrence of individual 100 cm^2 area false positive results are expected. The recount detector allows for a rapid evaluation of an area that indicates a higher than normal value. If one detector indicates a slightly elevated reading but the event is not confirmed by the second detector, the measurement is likely a false positive. Readings that approach an investigation level with either detector are averaged with the results from the other detector. The average value determines the need for follow up investigation.

Surveys taken with the SCM operating in the timer mode are presented as a single survey. Survey time for those detectors have been increased to minimize the probability of false positives. Timer mode surveys are performed when the cart mounted, motor driven SCM can not physically access an area due to area size, interference, or accessibility. The timer mode setting was 8 seconds, providing the same surface area measurement as the time measured by both the primary and recount operating at 2.5 cm/sec.

5.4.1 SCM/SIMS Sensitivity

SCM/SIMS data was utilized to satisfy the scan requirement only for the Building 729 survey (TSA measurements were performed with the NE Electra. The Electra MDC is verified in a radiological engineering site operations technical basis document entitled "Methods to Demonstrate Compliance with Performance Requirements for Swipe Counting and Portable Contamination Survey Instrumentation used to Evaluate Property and Waste for Unrestricted Release", dated June 7, 1995). However, due to the fact that the instrument software reports data for every 100 cm^2 area, and performs averaging over every one square-meter area, a discussion ensues that provides a comparison of each SCM/SIMS result to the $DCGL_W$ and the $DCGL_{EMC}$. The SCM/SIMS sensitivity for the surveys performed in building 729 is presented in Appendix 4. All required instrument performance requirements are satisfied with SCM/SIMS survey methodology.

5.4.2 Survey Unit 72901 SCM/SIMS Data Summary

Auto-generated reports for all surveys conducted in survey unit 72901 are presented in Volume 2, Attachment D. The following table summarizes the surveys conducted in survey unit 72901:

Table 5.1
Survey Unit 72901 SCM/SIMS Data Summary

Survey Sub-unit	Area Description	Highest 1 m^2 Average ($dpm/100\ cm^2$)	Number exceeding $DCGL_W$	Highest 100 cm^2 Area ($dpm/100\ cm^2$) (1)	Number exceeding $DCGL_{EMC}$	Efficiency (c/d)
72901001	Stairwell Landing Floor	14	0	137	0	0.35
72901002	Stairwell Landing Floor	18	0	135	0	0.35
72901003	Stairwell Landing South Wall	18	0	137	0	0.35
72901004	Stairwell Landing East Wall	13	0	170	0	0.35
72901005	Stairwell Landing North Wall	12	0	137	0	0.35
72901006	Stairwell Ceiling	13	0	137	0	0.35
72901007	Stairwell East Wall > 6'	8	0	99	0	0.35
72901008	Bridge Floor Adjacent to Hole	14	0	137	0	0.35
72901009	Bridge West Wall Over Hole	11	0	137	0	0.35
72901010	Bridge South Wall	22	0	103	0	0.35
72901011	Bridge East Wall	23	0	93	0	0.35
72901013	Bridge West Wall Corner	20	0	103	0	0.35
72901014	Bridge East Wall Corner	15	0	103	0	0.35
72901015	Bridge Floor Corner Strips	20	0	69	0	0.35
72901016	Bridge Ceiling	50	0	171	0	0.35
72901020	Plenum Floor – East Areas around N. Central Pedestal	14	0	170	0	0.35
72901021	Bridge – North Wall Adjacent to B779	8	0	102	0	0.35
72901022	East Deep Pit – Plenum Room, Walls and Floor	20	0	123	0	0.39
72901023	East Pit – Plenum Room, Tray	27	0	153	0	0.39
72901025	Plenum Room East Side Floor	15	0	192	0	0.35
729011c	Plenum Room Ceiling	27	0	137	0	0.35
729011e	Plenum Room East Wall	21	0	220	0	0.35
729011f	West Pit – Walls and Floor	46	0	274	1	0.35
729011eu	Plenum Room East Wall Upper Area	16	0	174	0	0.35
729011n primary	Plenum Room North Wall	21	0	251	0	0.25
729011n recount	Plenum Room North Wall	22	0	224	0	0.25
729011nu	Plenum Room North Wall Corners	13	0	137	0	0.35
729011su	Plenum Room South Wall Corners	13	0	171	0	0.35
729011tc	Plenum room trench	62	0	378	1	0.35

17

Survey Sub-unit	Area Description	Highest 1 m^2 Average (dpm/100 cm^2)	Number exceeding $DCGL_W$	Highest 100 cm^2 Area (dpm/100 cm^2) (1)	Number exceeding $DCGL_{EMC}$	Efficiency (c/d)
729011wu	Plenum room west wall	12	0	102	0	0.35
729012c	Plenum room ceiling	30	0	188	0	0.35
729012f	Plenum Room East Pit-Floor and Walls	20	0	220	0	0.35
729012n	North wall	12	0	132	0	0.35
729012s	Plenum Room South Wall	25	0	171	0	0.35
729012w	Plenum Room West Wall	16	0	164	0	0.35
7290120p	Plenum Room Floor-Corners	25	0	241	0	0.35
7290121F-primary	Plenum Room East end of South Pedestal	34	0	255	0	0.25
7290121F-recount	Plenum Room East end of South Pedestal	36	0	239	0	0.25
729013s	Bridge south door	39	0	166	0	0.39
729014e	Bridge east door #11/729	36	0	171	0	0.35
729015f	Plenum Room southeast floor	100(2)	1	308	1	0.35
729015sw	Plenum Room Floor - SW Area	26	0	171	0	0.35
729015n	Stairwell Walls North	70	0	154	0	0.39
7290150f	Plenum Room floor	30	0	158	0	0.35
7290151f	Plenum Room floor-corners adjacent to walls and the south pedestal	33	0	137	0	0.35
7290152w	Plenum Room walls- 5 strips per wall	20	0	171	0	0.35
7290153f	Plenum Room Floor - NW Area	19	0	206	0	0.35
7290154f	West pedestal floor adjacent to pit	20	0	184	0	0.35
7290155f	South large pedestal- west side	20	0	171	0	0.35
7290156f	Plenum Room Floor East Side	33	0	240	0	0.35
729015ff	Plenum Room Floor Adjacent to West & North Central Pedestal	42	0	129	0	0.35
72901604	South wall along stairs going from ground floor to landing	12	0	137	0	0.35
729016f	Plenum Room South East Pedestal	36	0	137	0	0.35
729016fc	Plenum Room Pedestals North Central & South	44	0	171	0	0.35
729018fc	Plenum Room Floor Southwest	20	0	129	0	0.35
729019fc	Plenum Room East Pedestal	24	0	171	0	0.35
729019ff	Bridge Stairs-Risers and Steps	17	0	137	0	0.39
72901300-primary	Bridge Interior East Wall	28	0	310	1	0.25
72901300-recount	Bridge Interior East Wall	23	0	389	1	0.25
72901301-primary	Bridge Interior West Wall	30	0	295	0	0.25
72901301-recount	Bridge Interior West Wall	24	0	374	1	0.25
72901600	Plenum Room Deep Pit Tray	12	0	154	0	0.39

18

Survey Sub-unit	Area Description	Highest 1 m^2 Average (dpm/100 cm^2)	Number exceeding $DCGL_W$	Highest 100 cm^2 Area (dpm/100 cm^2) (1)	Number exceeding $DCGL_{EMC}$	Efficiency (c/d)
72901601	Plenum Room West Edge of South Pedestal	25	0	154	0	0.39
72901602	Plenum Room East Wall Plexiglass Window	13	0	62	0	0.39
72901603	Plenum Room Deep Pit Tray South Wall	4	0	31	0	0.39
72901800-primary	Bridge Floor	76	0	268	0	0.30
72901800-recount	Bridge Floor	48	0	238	0	0.30

(1) Represents the maximum value within a one-square meter area. Thus, the values cited for primary and recount detectors do not typically pertain to the same location.
(2) Survey Sub-Unit 729015f, grid coordinate 7-12, was limited to a surface area of 100 cm^2 area only. Therefore, the $DCGL_W$ does not apply.

Survey Unit 72901 consisted of the main plenum room, the stairwell and the bridge area. The plenum room contained two pits and several pedestals 2" to 4" high that were the foundation for the filter plenums. The stairwell included a landing area at the midpoint of the stairs. The bridge floor included a hole in the south end, a penetration for the main ventilation duct from the bridge to the plenum room.

Initial characterization surveys of the plenum room indicated minor contamination, with a maximum value of approximately 400 dpm/100 cm^2 with additional spots between 250 and 300 dpm/100 cm^2 on the pedestal surrounding the west pit, and on the west end of the southwest pedestal. Final remediation activities in building 729 involved removal of a liner from the pit. The pedestal surrounding the pit was removed and disposed of as radioactive waste. Approximately 10 feet of the southwest pedestal was also removed and disposed of as radioactive waste. An investigative survey of the floor performed following removal of the pedestals indicated that all areas were below the $DCGL_{EMC}$ and $DCGL_W$ (refer to Volume 3, Attachment F).

Initial characterization surveys of the west pit also indicated low levels of activity. A single 100 cm^2 area on the floor of the pit was determined to be approximately 337 dpm. Areas near the top of both the east and west wall of the pit indicated radioactivity in the range of 250 to 280 dpm/100 cm^2 distributed over areas of approximately 30 cm x 30 cm. Figure 5.1 is the two dimensional display of the pit area. The pit is represented as if the walls were laid out, with the floor area in the middle. The view is with the north wall toward the top of the display. The maximum 100 cm^2 area is in meter grid (2,3). The activity on the walls can be seen in meter grids (1,3), west wall, and (3,3), east wall. The areas were surveyed with a hand held NE Electra with a Model DP6 probe. These surveys confirmed the initial scan findings. The contaminated location on the floor was determined to be approximately 70 cm from the north wall of the pit and 40 cm from the east wall. The areas found on the walls were at the approximate mid points of the wall and extended from the top of the wall down approximately 35 cm. The areas as confirmed with the Electra, were marked and subsequently remediated. A needle gun was used to remove approximately 1/8" of the surface in areas roughly 40 cm x 40 cm around each of the three areas. The surface materials removed were disposed of as radioactive waste. Subsequent final status surveys with hand held instruments indicated that the pit area was below the $DCGL_{EMC}$ in the remediated areas. Final survey of the west pit is presented in Volume 2, Attachment D.

The final status surveys for survey unit 72901 indicates that all areas surveyed met the $DCGL_W$. Several survey sub-units indicated measurements in excess of the 225 dpm/100cm^2 (75% of the $DCGL_{EMC}$) investigation level. These locations were investigated and dispositioned as less than the $DCGL_{EMC}$ (refer to section 5.4.5 and Volume 3, Attachment F).

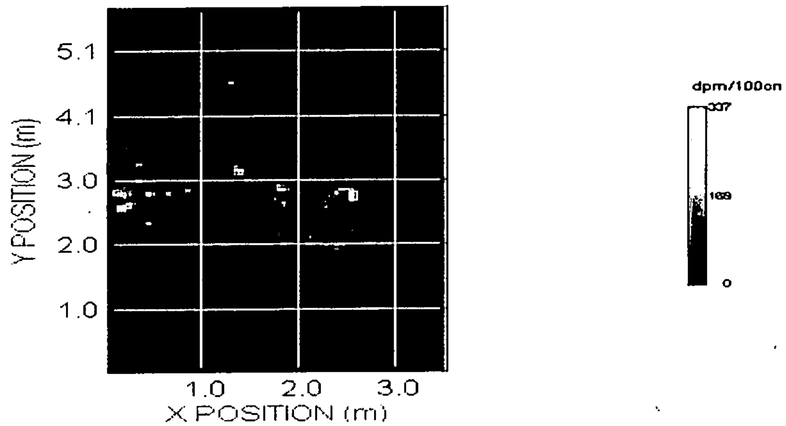


Figure 5.1
West Pit Initial Survey

5.4.3 Survey Unit 72902 Summary

Auto-generated reports for all surveys conducted in survey unit 72902 are presented in Volume 2, Attachment D. The following table summarizes the surveys conducted in survey unit 72902:

Table 5.2
Survey Unit 72902 SCM/SIMS Data Summary

Survey Sub-unit	Area Description	Highest 1 m^2 Average (dpm/100 cm^2)	Number exceeding $DCGL_W$	Highest 100 cm^2 Area (dpm/100 cm^2) (1)	Number exceeding $DCGL_{EMC}$	Efficiency (c/d)
7290250f	diesel generator room floor	34	0	171	0	0.35
729027f	Airlock Floor	12	0	102	0	0.35
729027wn	Airlock North Wall	11	0	137	0	0.35
729027ws	Airlock South Wall	15	0	137	0	0.35
729027ww	Airlock West Wall	17	0	171	0	0.35
729028f	Hallway Floor	11	0	102	0	0.35
729029f	Lavatory Floor	16	0	137	0	0.35
729029wn	Lavatory North Wall	20	0	171	0	0.35
72902300 primary	Diesel Generator Room North Wall	33	0	323	1	0.25
72902300 recount	Diesel Generator Room North Wall	21	0	222	0	0.25
72902301	Diesel Generator Room North	24	0	330	1	0.25

primary	Wall					
72902301 recount	Diesel Generator Room West Wall	27	0	240	0	0.25
72902302 primary	Diesel Generator Room East Wall	36	0	289	0	0.25
72902302 recount	Diesel Generator Room East Wall	35	0	251	0	0.25
72902303 primary	Control Room North Wall	20	0	215	0	0.25
72902303 recount	Control Room North Wall	15	0	294	0	0.25
72902304 primary	Control Room West Wall	21	0	194	0	0.25
72902304 recount	Control Room West Wall	17	0	189	0	0.25
72902305 primary	Control Room South Wall	22	0	289	0	0.25
72902305 recount	Control Room South Wall	13	0	191	0	0.25
72902306 primary	Control Room East Wall	24	0	309	1	0.25
72902306 recount	Control Room East Wall	22	0	210	0	0.25

(1) Represents the maximum value within a one-square meter area. Thus, the values cited for primary and recount detectors do not typically pertain to the same location.

Survey Unit 72902 consisted of the diesel generator room, control room, lavatory, hallway and airlock entrance into the plenum room. All areas surveyed showed 1 m^2 average activity to be below the applicable DCGL. Several survey sub-units indicated measurements in excess of the 225 dpm/100cm^2 (75% of the $DCGL_{EMC}$) investigation level. These locations were investigated and dispositioned as less than the $DCGL_{EMC}$ (refer to section 5.4.5 and Volume 3, Attachment F).

5.4.4 Survey Unit 72903 Summary

Auto-generated reports for all surveys conducted in survey unit 72903 are presented in Volume 2, Attachment D. The following tables summarize the surveys conducted in survey unit 72903:

Table 5.3
Survey Unit 72903 SCM/SIMS Data Summary

Survey Sub-unit	Area Description	Highest 1 m^2 Average (dpm/100 cm^2)	Number exceeding $DCGL_W$	Highest 100 cm^2 Area (dpm/100 cm^2) (1)	Number exceeding $DCGL_{EMC}$	Efficiency (c/d)
72903001	exterior stairwell east wall	46	0	274	0	0.35
72903002	exterior stairwell south wall	55	0	308	1	0.35
72903003	exterior stairwell west wall	64	0	239	0	0.35
72903008	exterior bridge east wall and ledge	70	0	240	0	0.35
72903017	exterior east wall	30	0	210	0	0.35
72903018	Shield wall adjacent to door protruding from east exterior wall	29	0	205	0	0.35

72903019	East exterior foundation wall	19	0	171	0	0.35
729031w	Exterior Wall West	26	0	214	0	0.35
729031na	Exterior Wall North, East Half	36	0	257	0	0.35
729031nb	Exterior Wall North, West Half	55	0	214	0	0.35
729032sa	Exterior Wall South, West Half	63	0	386	1	0.35
729032sb	Exterior Wall South, East Half	72	0	300	1	0.35
729035u	Exterior Underside of Bridge	45	0	257	0	0.35

(1) Represents the maximum value within a one-square meter area. Thus, the values cited for primary and recount detectors do not typically pertain to the same location.

Survey Unit 72903 consists of external surfaces of the building. 100% surface surveys were performed up to two meters from grade, with a minimum of 10% of the area above two meters surveyed. The concrete block walls are supported by a concrete foundation, the height of which varies with the slope of the land around the building. In many areas, the surveyed area extended beyond the 2-meter height required. Galvanized metal roof flashing extends approximately 8 to 10 inches from the top of the exterior walls, and along the top of the bridge. The exterior of the stairwell also has flashing along the base. Surveys showed no activity above the 1 m^2 average activity $DCGL_W$. Several survey sub-units indicated measurements in excess of the 225 dpm/100cm^2 (75% of the $DCGL_{EMC}$) investigation level. These locations were investigated and dispositioned as less than the $DCGL_{EMC}$ (refer to section 5.4.5 and Volume 3, Attachment F).

Table 5.4 presents the flashing survey results, which are compared to the uranium $DCGL_W$ of 5,000 dpm/100cm^2 and $DCGL_{EMC}$ of 15,000 dpm/100cm^2 (refer to section 5.4.5 for justification).

Table 5.4
Survey Unit 72903 SCM/SIMS Data Summary for Flashing

Survey Sub-unit	Area Description	Highest 1 m^2 Average (dpm/100 cm^2)	Number exceeding $DCGL_W$	Highest 100 cm^2 Area (dpm/100 cm^2)	Number exceeding $DCGL_{EMC}$	Efficiency (c/d)
72903004	exterior stairwell east wall flashing	120	0	235	0	0.35
72903005	exterior stairwell south wall flashing	89	0	376	0	0.35
72903006	exterior stairwell west wall flashing	30	0	274	0	0.35
72903009	exterior west wall flashing	83	0	239	0	0.35
72903010	exterior east wall flashing	125	0	377	0	0.35

5.4.5 Investigations

Follow up investigations were conducted for each measurement in excess of 75% of the $DCGL_W$ or $DCGL_{EMC}$. Table 5.5 summarizes the results of the investigations. SCM survey results in excess of 225 dpm/100cm^2 (75% of the $DCGL_{EMC}$) but less than 300 dpm/100cm^2 were investigated by one of two methods. The first was to average the

22

primary and recount detector results. If the results were less than 225 dpm/100cm^2, then no further investigation was required. The second method consisted of performing a survey of the flagged area with a hand held instrument, the NE Electra with a DP6 probe.

SCM survey results in excess of 300 dpm/100cm^2, or primary plus recount detector result averages greater than 225 dpm/100cm^2, were investigated by utilizing a hand held instrument, a NE Electra with a DP6 probe.

Investigation surveys utilizing the NE Electra were performed by first scanning the surrounding suspect area to determine if any elevated activity areas could be identified. Following the scan, a shielded local area background measurement (one minute count) and an unshielded direct measurement (one minute count) were obtained in the area of highest activity identified during the scan. If the investigations that were performed by averaging the primary and recount detectors resulted in values less than 225 dpm/100cm^2, then, no further actions were required. Each SCM measurement location investigated was documented on an investigation form (refer to Volume 3, Attachment F). If more than one elevated measurement is discovered in a given grid, separate investigation forms are included for each elevated measurement. As indicated by Table 5.5, all SCM and NE Electra investigation results were less than the $DCGL_{EMC}$.

Additional NE Electra investigations were performed for survey sub-units 72903001, 72903002, 72903003, and 72903008 (refer to Volume 3, Attachment F). These investigations were initiated by Millennium Services, Inc. when consistently high one-square meter averages were observed (ranging from 40 to 50 dpm) on concrete block wall of the stairwell exteriors and the bridge east wall and ledge exteriors. All investigations were less than the $DCGL_W$.

Survey sub-units 72903004, 72903005, 72903006, 72903009, and 72903010 (roof flashing) of survey unit 72903 indicated increased activity on the east wall flashing and the exterior stairwell south wall flashing exceeding the $DCGL_{EMC}$. Two measurement locations on the flashing exceeded the $DCGL_W$. Investigations performed by site Radiological Control Technicians using a NE Technologies Electra with a DP6 Probe confirmed the increased activity levels. Experience in other Decontamination and Decommissioning projects at RFETS has indicated that increased activity on roof flashing was due to naturally occurring Polonium-210, a daughter product in the uranium-radon decay chain, as confirmed by several roof samples collected during previous projects (Memorandum from Don Harward to Alan Parker, dated September, 1997, "Radiological Requirements for Release of the 690 and 891 Trailer Clusters" – DJH-028-97). Because Polonium-210 has an alpha energy of 5.3 MeV, comparable to the average Plutonium-239 alpha energy of 5.15 MeV, the isotopes cannot be discriminated with typical field instruments.

Confirmation of the isotopic content was performed by obtaining two coupon samples at areas of elevated activity as determined with a NE Electra instrument. The samples were submitted to the RFETS Analytical Services Division (ASD) for alpha spectroscopy. The results confirmed the presence of Polonium-210 (refer to Volume 3, Attachment F – Safe Sites Interoffice Correspondence). No plant related radionuclides, including plutonium, americium, or uranium were detected on the sample. Thus the elevated field measurements are attributed to Polonium-210.

Because an isotopic analysis was performed to confirm that transuranics were not present in the sample, and Polonium-210 is in the decay chain of Uranium-238, the measurement results were compared to the uranium $DCGL_W$ of 5000 dpm/100 cm^2. This was considered an acceptable deviation from the "Closeout Radiological Survey Plan for the 779 Cluster", Revision 2, due to the fact that isotope specific laboratory analyses were performed. All measurements collected on the flashing from both the SCM and the hand held NE Electra were below the 5000 dpm/100 cm^2 uranium $DCGL_W$. The sub-unit reports in Volume 2, Attachment D compare SCM measurements to uranium DCGLs.

Table 5.5
Summary of Investigation Survey Results

Survey Sub-Unit	Grid (X,Y) Coordinates	Original SCM/SIMS Flagged Result (dpm/100 cm^2)	SCM/SIMS Calculated Maximum (dpm/100 cm^2) (1)	Investigation Results (dpm/100 cm^2) (2)	$DCGL_{EMC}$ Met
729011f	2,3	274	N/A	67	Yes
729011n	4,1	235	157	N/A	Yes
	14,1	251	238	10	Yes
	12,2	239	189	N/A	Yes
	13,2	227	201	N/A	Yes
	14,2	246	208	N/A	Yes
729011tc	1,1	257	N/A	105	Yes
	1,2	265	N/A	87	Yes
	1,3	378	N/A	64	Yes
	1,4	276	N/A	46	Yes
	1,4	276	N/A	142	Yes
	1,4	293	N/A	96	Yes
7290120p	17,11	241	N/A	34	Yes
7290121f	3,2	255	214	N/A	Yes
	3,1	244	166	N/A	Yes
	5,1	248	190	N/A	Yes
729015f	3,5	308	N/A	19	Yes
7290156f	1,4	240	N/A	34	Yes
72901300	4,1	310	205	24	Yes
	4,2	389	290	24	Yes
	6,2	294	202	N/A	Yes
	1,2	289	238	38	Yes
	2,1	294	249	29	Yes
	3,2	289	195	N/A	Yes
	4,2	389	290	19	Yes
	9,1	290	243	10	Yes
	8,2	242	177	N/A	Yes
72901301	1,2	374	238	19	Yes
	5,1	309	195	24	Yes
	1,2	310	259	24	Yes
	9,1	273	231	38	Yes
	10,1	280	234	0	Yes
	8,2	294	238	24	Yes
	9,2	284	233	5	Yes
72901800	1,13	261,238	250	9	Yes
	1,9	237	199	N/A	Yes
	1,8	234	193	N/A	Yes
	2,2	225	218	N/A	Yes
	1,4	265	208	N/A	Yes
	2,10	238	217	N/A	Yes
	1,14	264	186	N/A	Yes
	2,14	268	221	N/A	Yes

24

Survey Sub-Unit	Grid (X,Y) Coordinates	Original SCM/SIMS Flagged Result (dpm/100 cm^2)	SCM/SIMS Calculated Maximum (dpm/100 cm^2) (1)	Investigation Results (dpm/100 cm^2) (2)	DCGL$_{EMC}$ Met
72902300	2,2	323, 232	278	19	Yes
	2,2	256, 232	244	14	Yes
	2,2	313	231	14	Yes
72902301	2,2	330	214	24	Yes
	2,1	240	148	5	Yes
72902302	2,1	289	226	29	Yes
	3,2	251	126	N/A	Yes
	3,1	249	165	N/A	Yes
	1,1	225	113	N/A	Yes
	4,1	241	121	N/A	Yes
	4,1	236	142	N/A	Yes
72902303	2,1	294	147	N/A	Yes
72902305	1,1	289	145	N/A	Yes
72902306	1,1	310	206	19	Yes
729031na	10,2	257	N/A	42	Yes
729032sa	2,1	295	N/A	9	Yes
	2,1	257	N/A	23	Yes
	3,1	385	N/A	0	Yes
	3,1	342	N/A	18	Yes
	3,1	343	N/A	23	Yes
	5,1	257	N/A	32	Yes
	11,1	257	N/A	5	Yes
	1,2	299	N/A	14	Yes
	2,2	249	N/A	18	Yes
	3,2	257	N/A	23	Yes
	6,2	255	N/A	23	Yes
729032sb	2,1	257	N/A	9	Yes
	3,1	257	N/A	14	Yes
	4,1	257	N/A	18	Yes
	5,1	238	N/A	14	Yes
	7,1	257	N/A	5	Yes
	3,2	254	N/A	14	Yes
	8,2	257	N/A	18	Yes
	8,2	257	N/A	9	Yes
	8,4	300	N/A	38	Yes
	8,4	251	N/A	9	Yes
729035u	2,1	257	N/A	59	Yes
72903001	1,2	274	N/A	74	Yes
	1,2	228	N/A	42	Yes
	1,1	236	N/A	46	Yes
72903002	5,1	240	N/A	55	Yes
	4,2	308	N/A	43	Yes
	6,2	240	N/A	46	Yes
72903003	2,2	239	N/A	60	Yes
	1,2	226	N/A	37	Yes
72903004	Flashing	235	N/A	N/A	Yes (3)
72903005	Flashing	377	N/A	N/A	Yes (3)
72903006	Flashing	274	N/A	N/A	Yes (3)
72903008	1,1	240	N/A	47	Yes
	2,1	240	N/A	56	Yes
	2,1	240	N/A	51	Yes
72903009	Flashing	240	N/A	N/A	Yes (3)
72903010	Flashing	377	N/A	N/A	Yes (3)

(1) A recount detector is not utilized with a corner detector. Thus, an average value is not calculated.

(2) An investigation is not required with the NE Electra when a single measurement is < 300 dpm/100 cm^2 and the average result is < 225 dpm/100 cm^2.

(3) Coupon samples collected. Activity attributed to Po-210.

6.0 Conclusion

All survey data collected from Building 729 meets the DCGLs as defined by the Closeout Radiological Survey Plan for the 779 Cluster. Therefore, the building is suitable for unrestricted release. The estimated sanitary waste volume for Building 729 is 1,032.28 (estimated tons). This is equivalent to a total of 83.89 roll-off loads.

APPENDIX 1

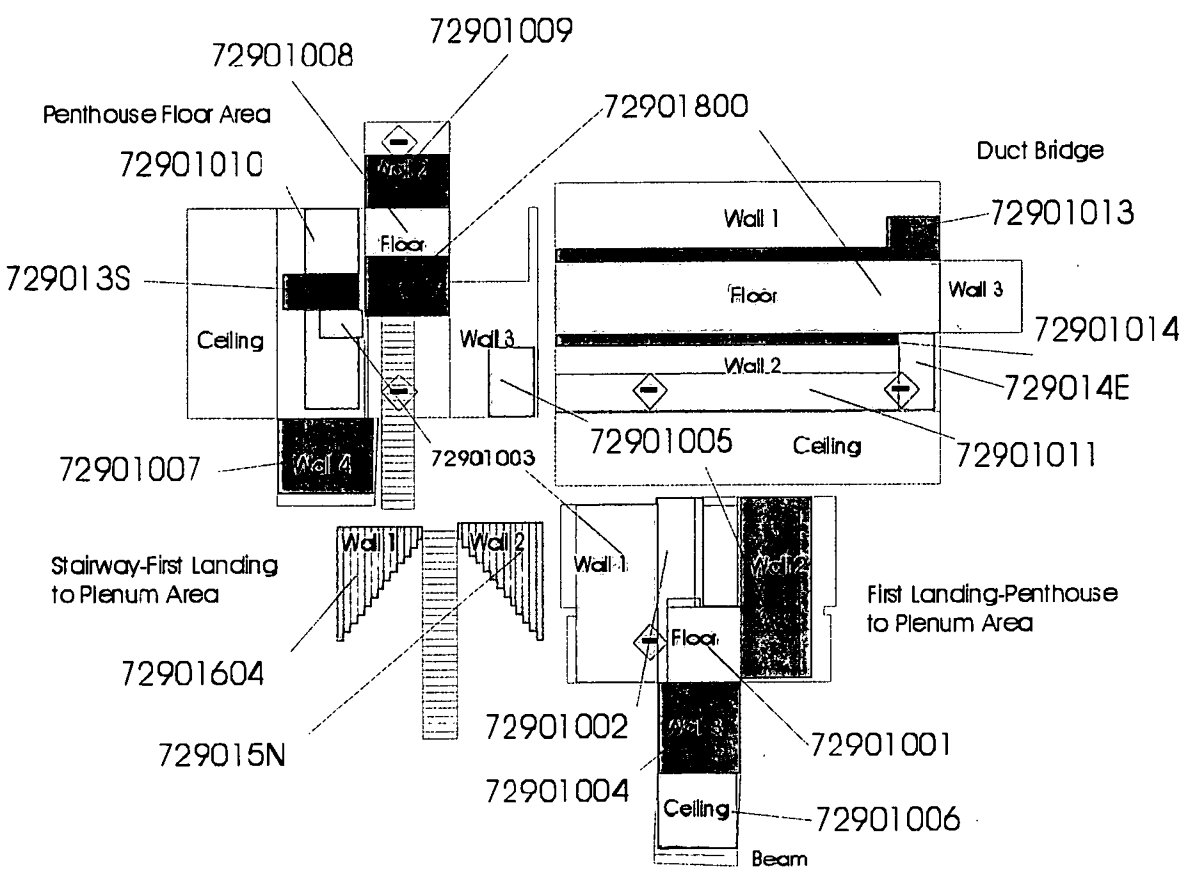
SCM/SIMS Scan Survey Overlay Maps

27

RADIOLOGICAL CLOSEOUT SURVEY FOR THE 779 CLUSTER

Survey Area: A | Survey Unit: 72901 | Classification: 2

Building: 729 | Survey Unit Description: Bldg. 729 Penthouse & Duct Bridge

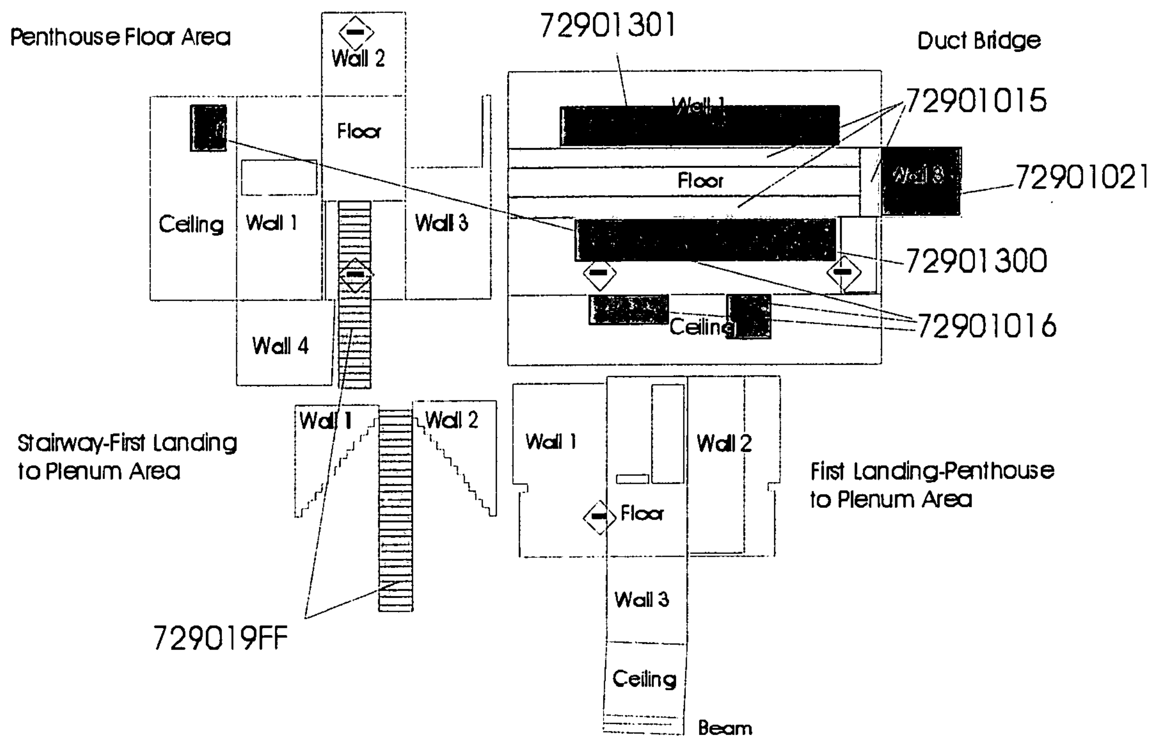


28

RADIOLOGICAL CLOSEOUT SURVEY FOR THE 779 CLUSTER

Survey Area: A | Survey Unit: 72901 | Classification: 2

Building: 729 | Survey Unit Description: Bldg. 729 Penthouse & Duct Bridge

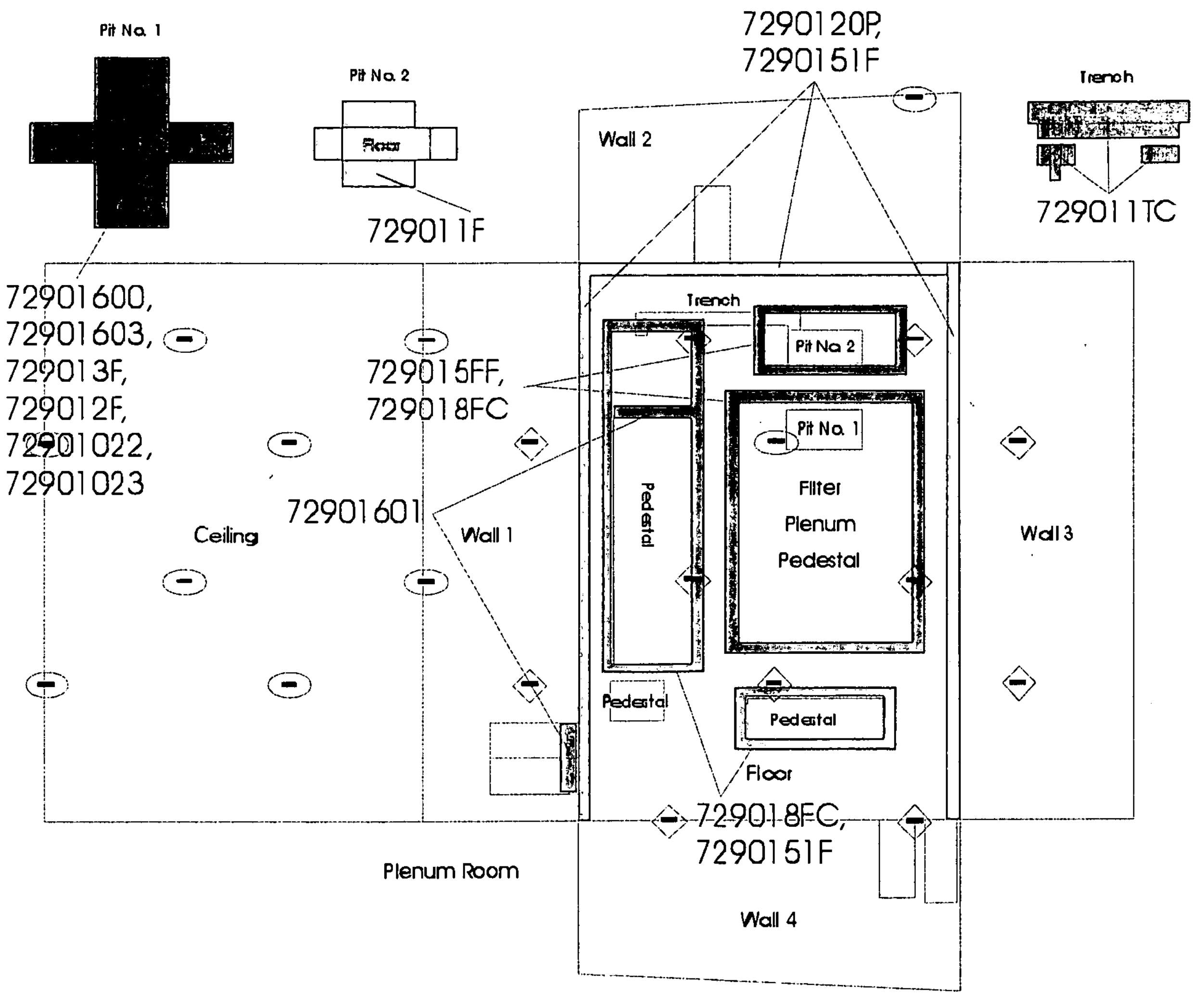


29

RADIOLOGICAL CLOSEOUT SURVEY FOR THE 779 CLUSTER

Survey Area: A | Survey Unit: 72901 | Classification: 2

Building: 729 | Survey Unit Description: Bldg 729 Plenum Area

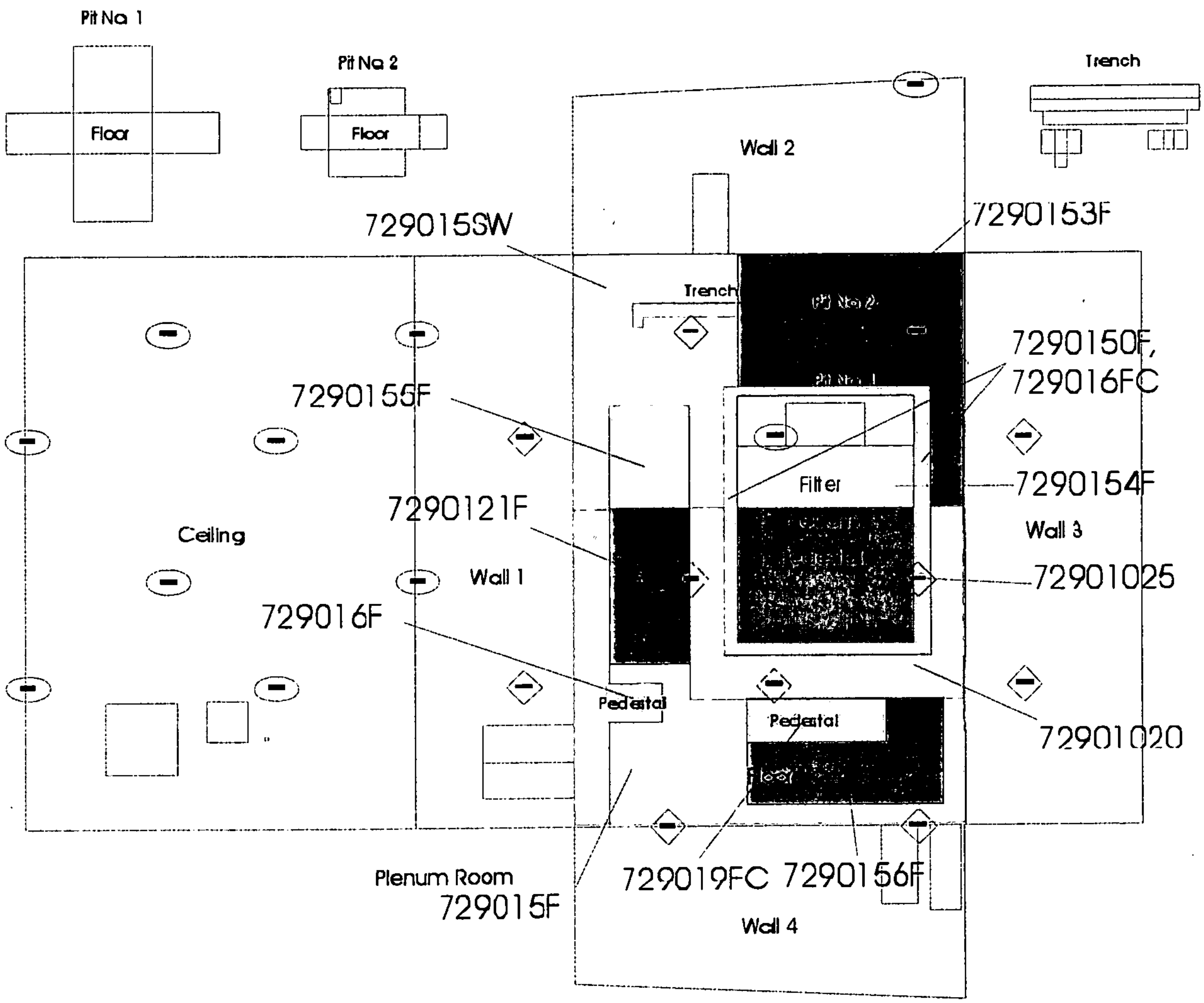


30

RADIOLOGICAL CLOSEOUT SURVEY FOR THE 779 CLUSTER

Survey Area: A | Survey Unit: 72901 | Classification: 2

Building: 729 | Survey Unit Description: Bldg. 729 Plenum Area

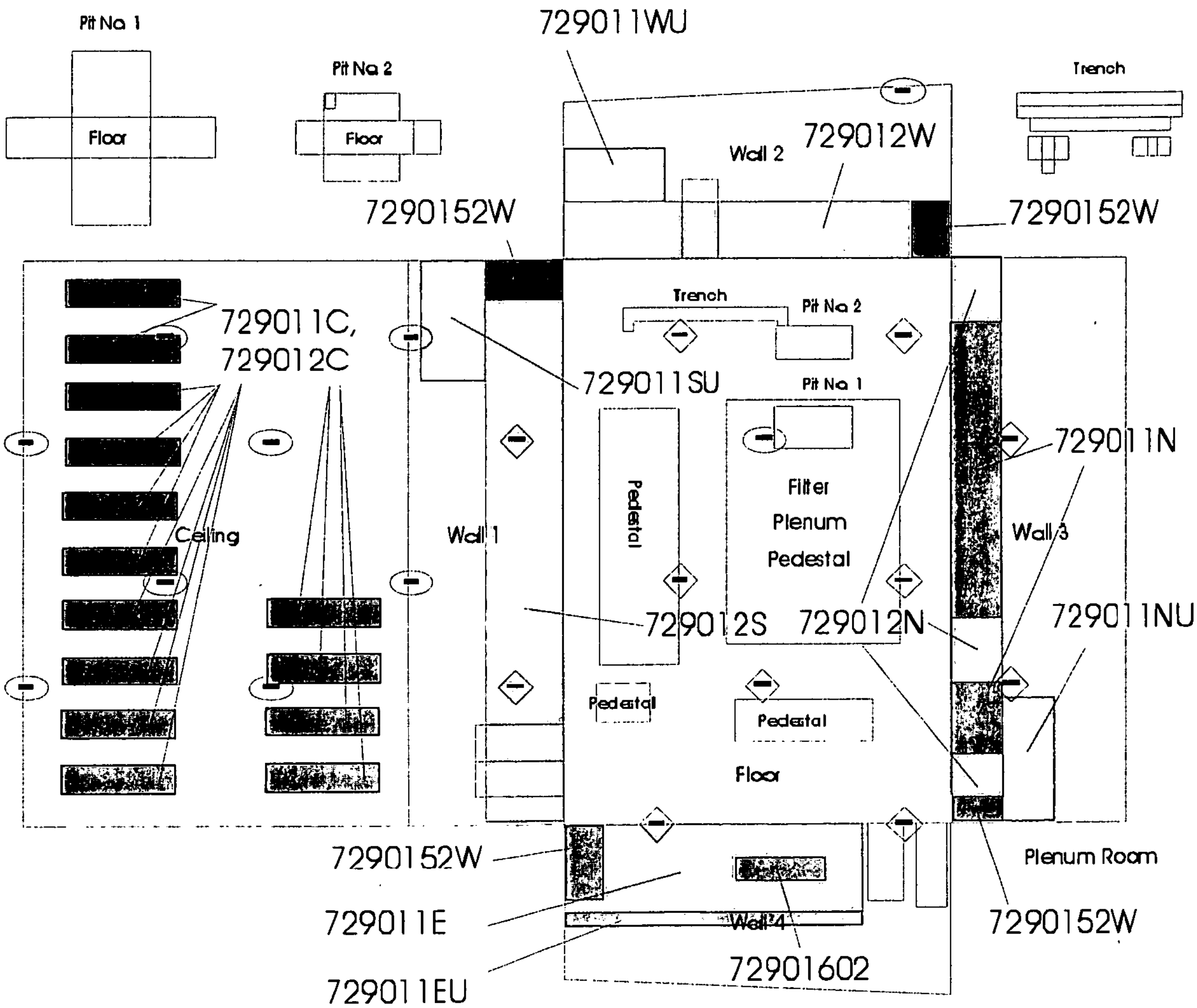


31

RADIOLOGICAL CLOSEOUT SURVEY FOR THE 779 CLUSTER

Survey Area: A Survey Unit: 72901 Classification: 2

Building: 729 Survey Unit Description: Bldg. 729 Plenum Area



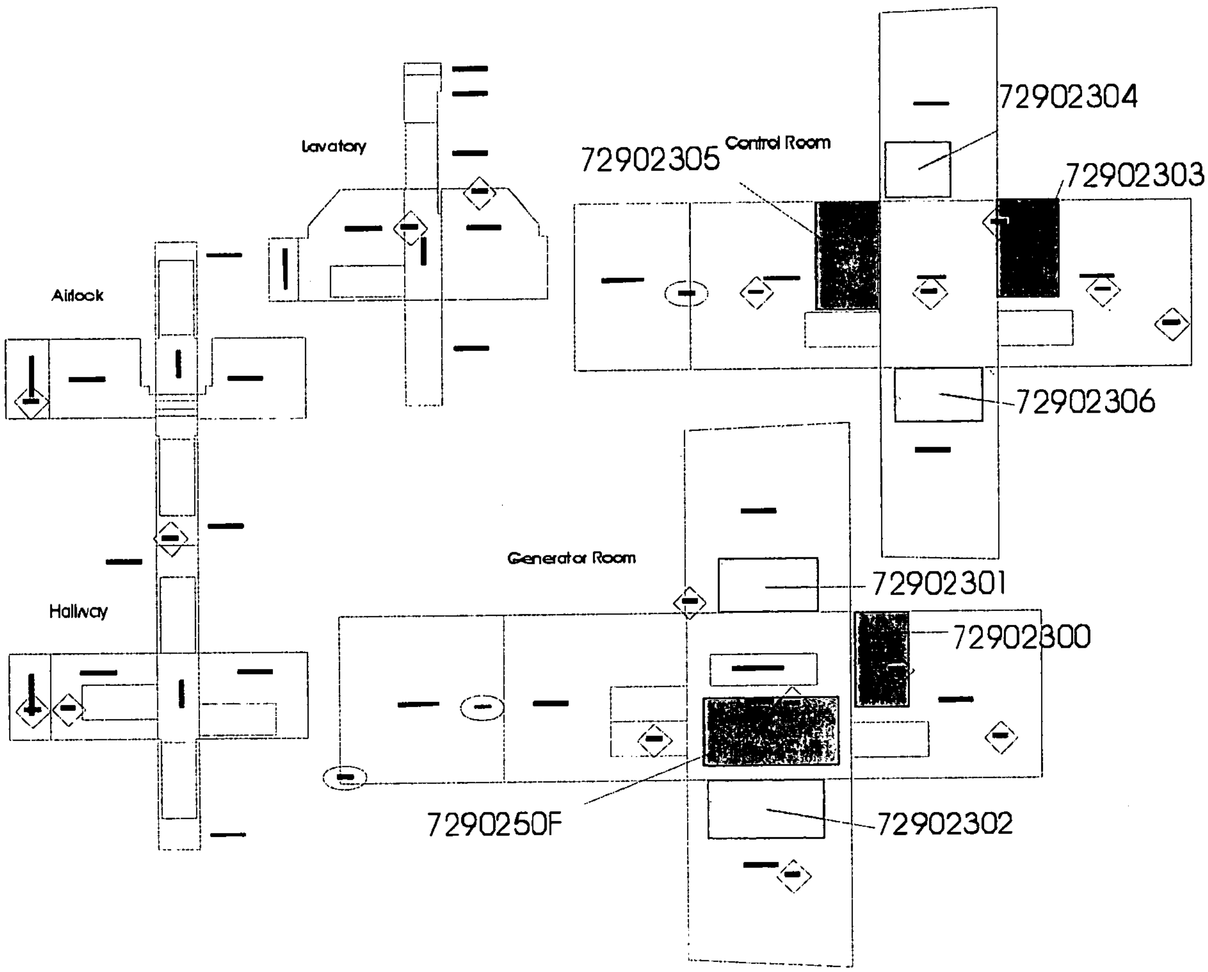
32

RADIOLOGICAL CLOSEOUT SURVEY FOR THE 779 CLUSTER

Survey Area: A　　Survey Unit: 72902　　Classification: 3

Building: 729

Survey Unit Description: Bldg. 729 Generator Room, Control Room, Airlock/Hallway & Lavatory

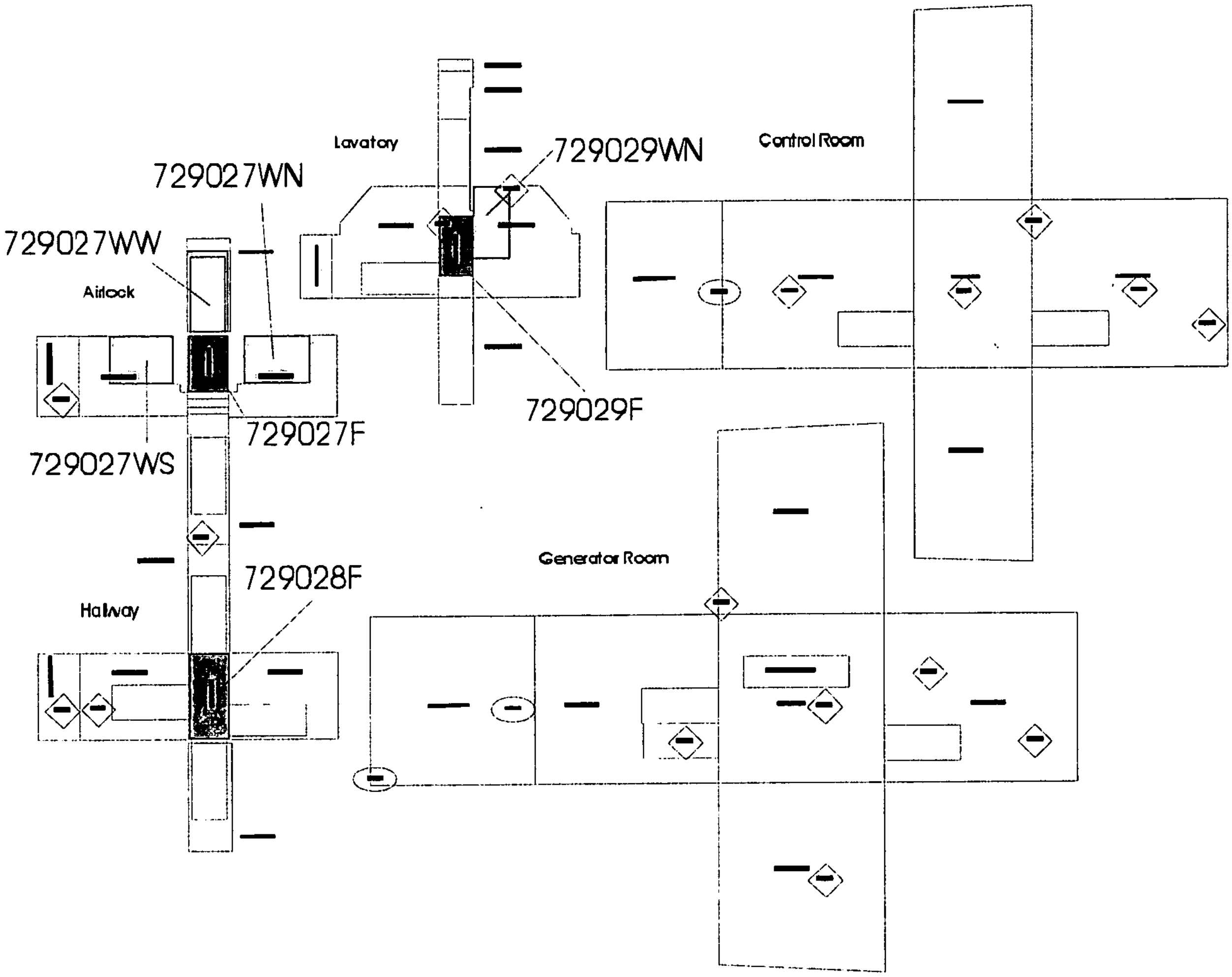


RADIOLOGICAL CLOSEOUT SURVEY FOR THE 779 CLUSTER

Survey Area: A Survey Unit: 72902 Classification: 3

Building: 729

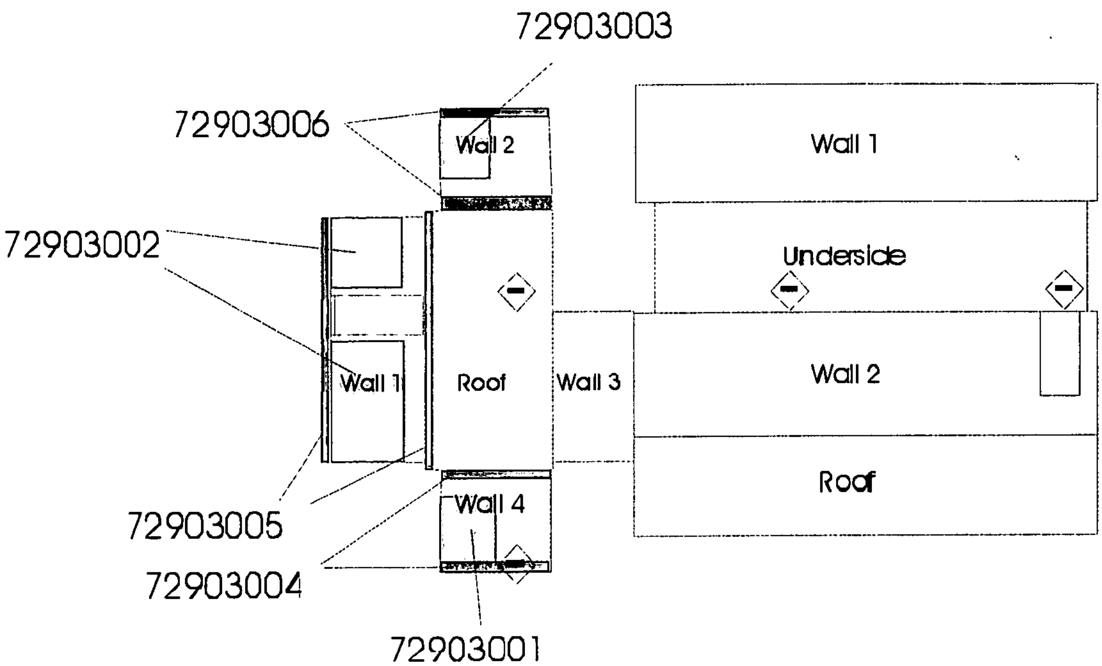
Survey Unit Description: Bldg. 729 Generator Room, Control Room, Airlock/Hallway & Lavatory



RADIOLOGICAL CLOSEOUT SURVEY FOR THE 779 CLUSTER

Survey Area: A Survey Unit: 72903 Classification: 2

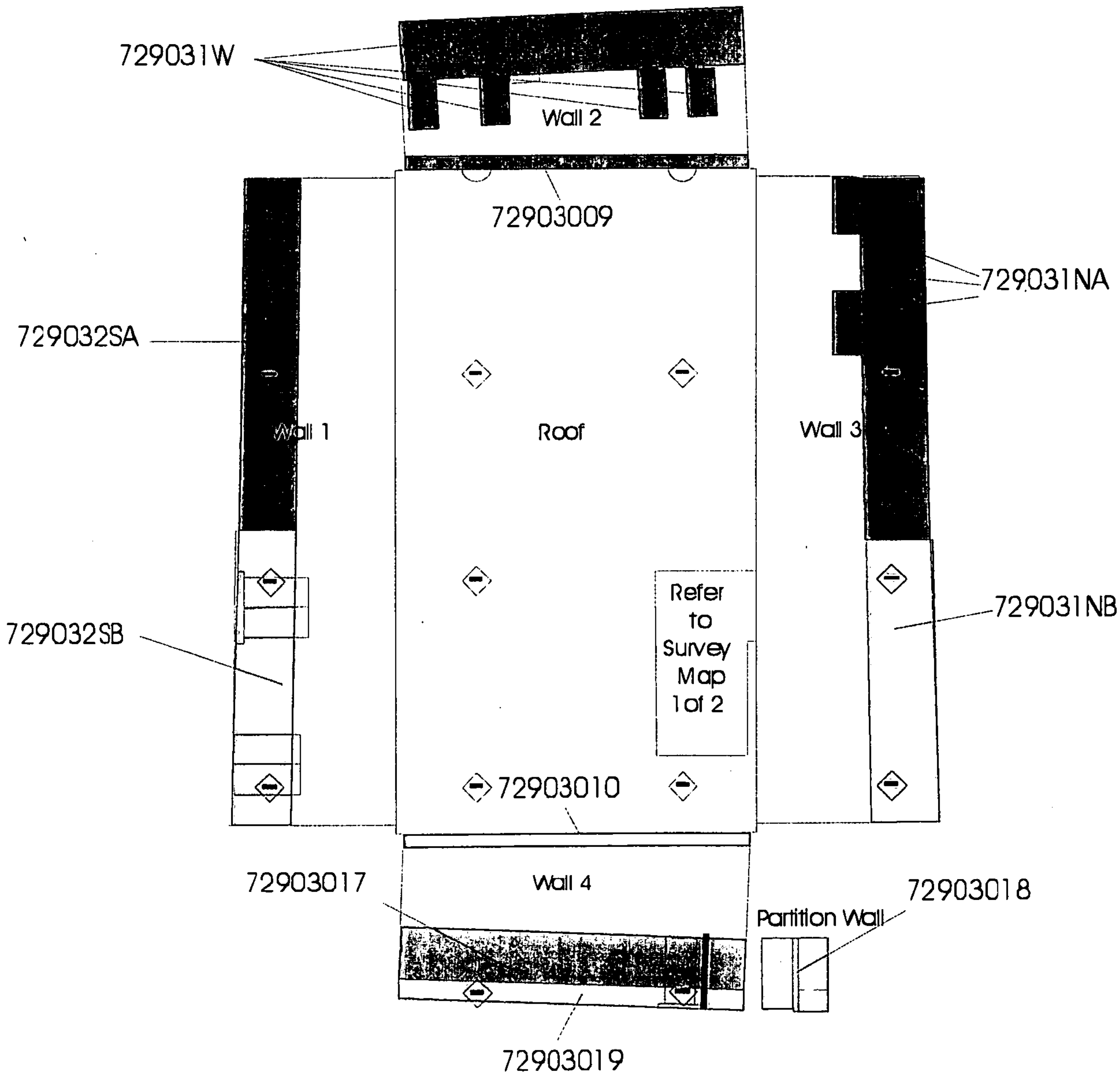
Building: 729 Survey Unit Description: Bldg. 729 Outside Walls, Roof & Duct Bridge



RADIOLOGICAL CLOSEOUT SURVEY FOR THE 779 CLUSTER

Survey Area: A   Survey Unit: 72903   Classification: 2

Building: 729   Survey Unit Description: Bldg. 729 Outside Walls, Roof, and Duct Bridge



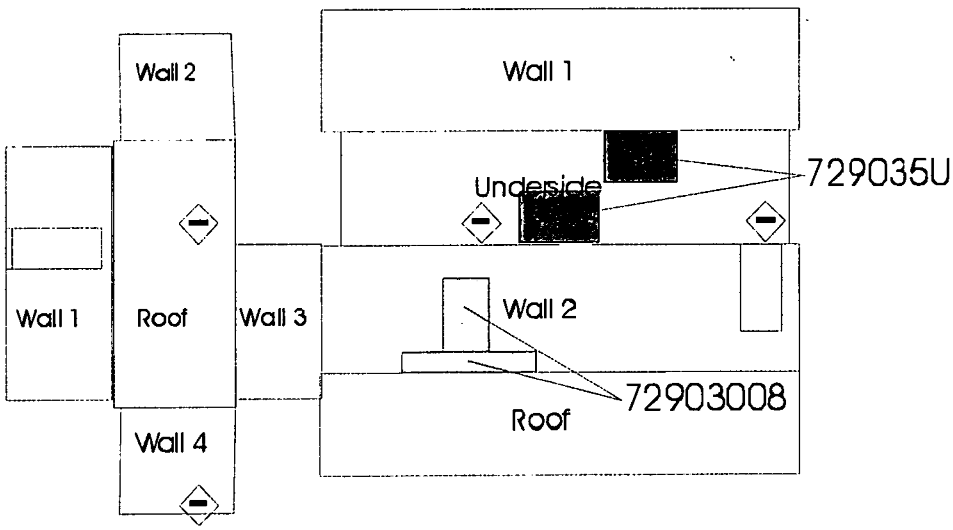
36

RADIOLOGICAL CLOSEOUT SURVEY FOR THE 779 CLUSTER

Survey Area: A   Survey Unit: 72903   Classification: 2

Building: 729

Survey Unit Description: Bldg. 729 Outside Walls, Roof & Duct Bridge



37

Appendix 2

SCM/SIMS Quality Control Charts

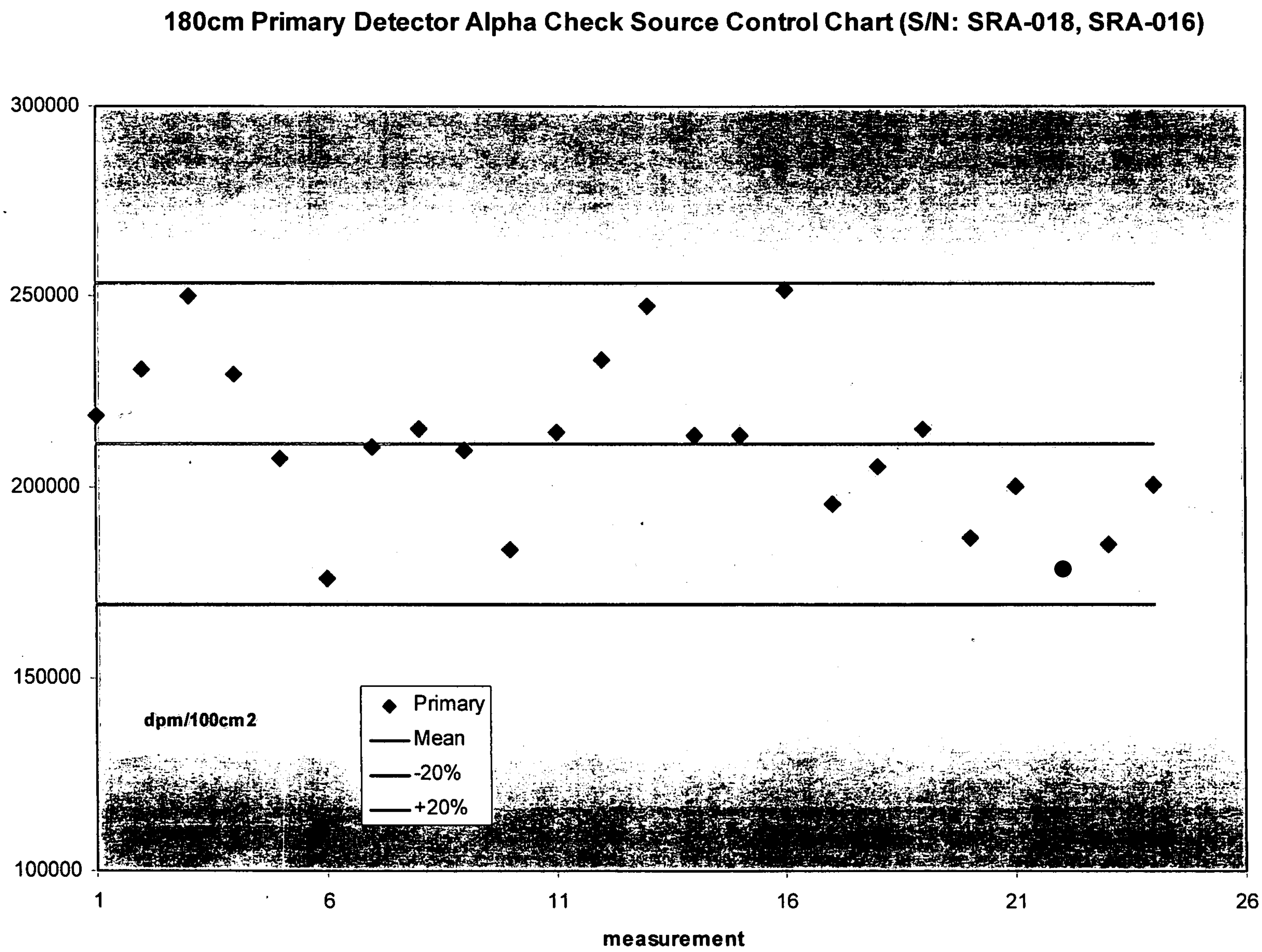
QC Control Charts

The QC control charts follow. The QC survey is to be distinguished from the daily source check. The daily source check allows the survey technician to determine that the instrument is responding within acceptable values for total background subtracted counts using a radioactive source. The QC survey is used to continuously update the control charts. The control charts are used to determine the efficiency of each detector assembly, verify adequate system performance, and to observe trends that may indicate monitoring system problems.

The control chart plots a mean of the Pu-238 source measurements (source strength = 194,400 dpm, reference Attachment E, Source Certificate, NIST Traceability). It also shows the range of plus and minus 20% from the mean value. A typical QC survey contains at least six measurements (or twelve, if a recount assembly is used), which consist of at least three before and three after the radiological survey. Additionally, every three hours, three (or six) more measurements are obtained during the survey.

In a few cases, values have fallen outside of 20% from the mean. Singular events outside the range are not considered failures in the measurement process provided that the other values are within the acceptable range. Single events outside the range are treated as normal statistical occurrences. Therefore, the following charts show no trends that would require resurvey of the Final Status Surveys.

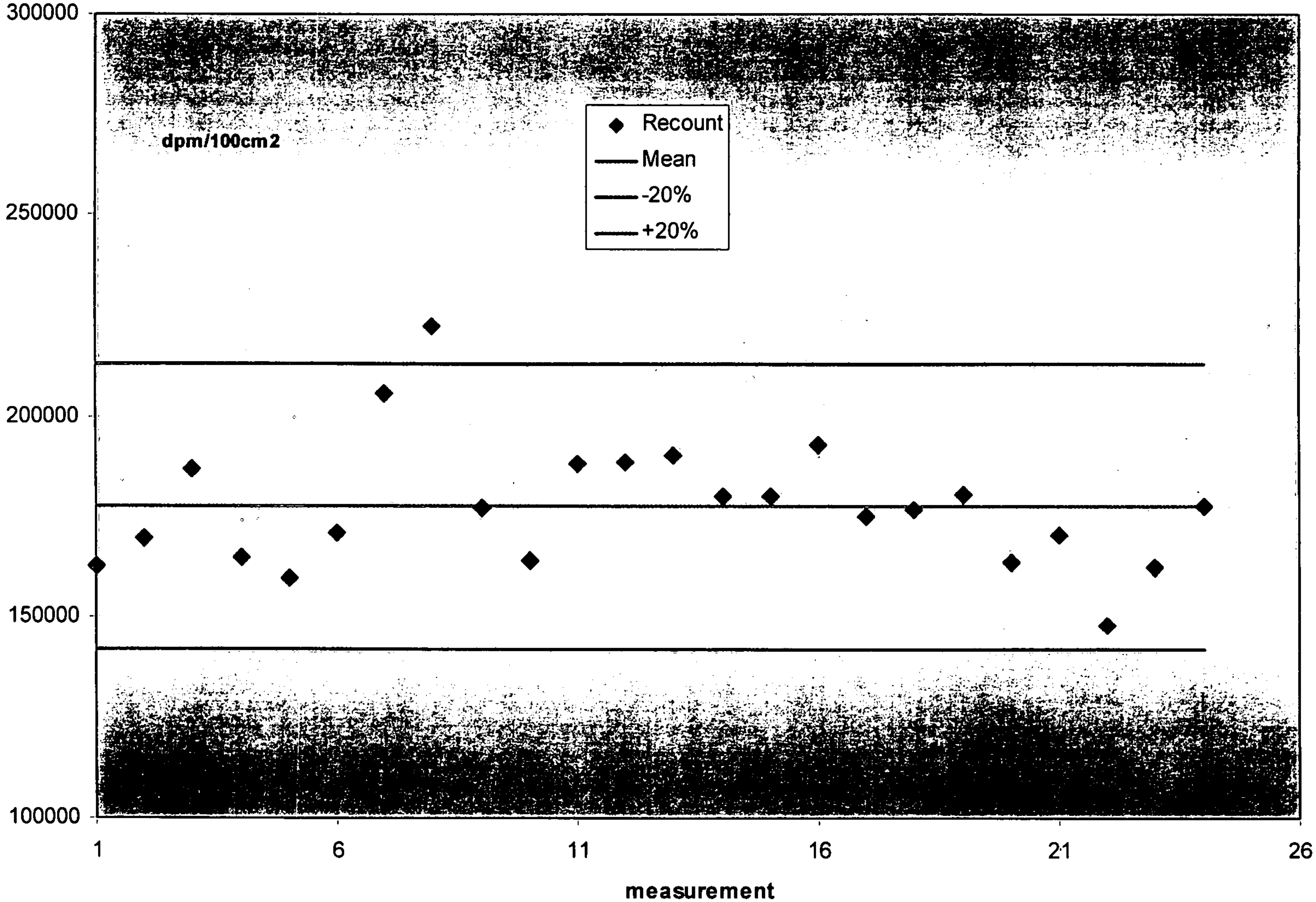
There have been cases during the Building 779 survey where the QC control charts indicated a malfunctioning detector. These surveys were not published as Final Status Surveys. New surveys as well as QC surveys were performed. The problems in this case were due to inadequate gas flow to the detector due to a kink in the gas supply hose.



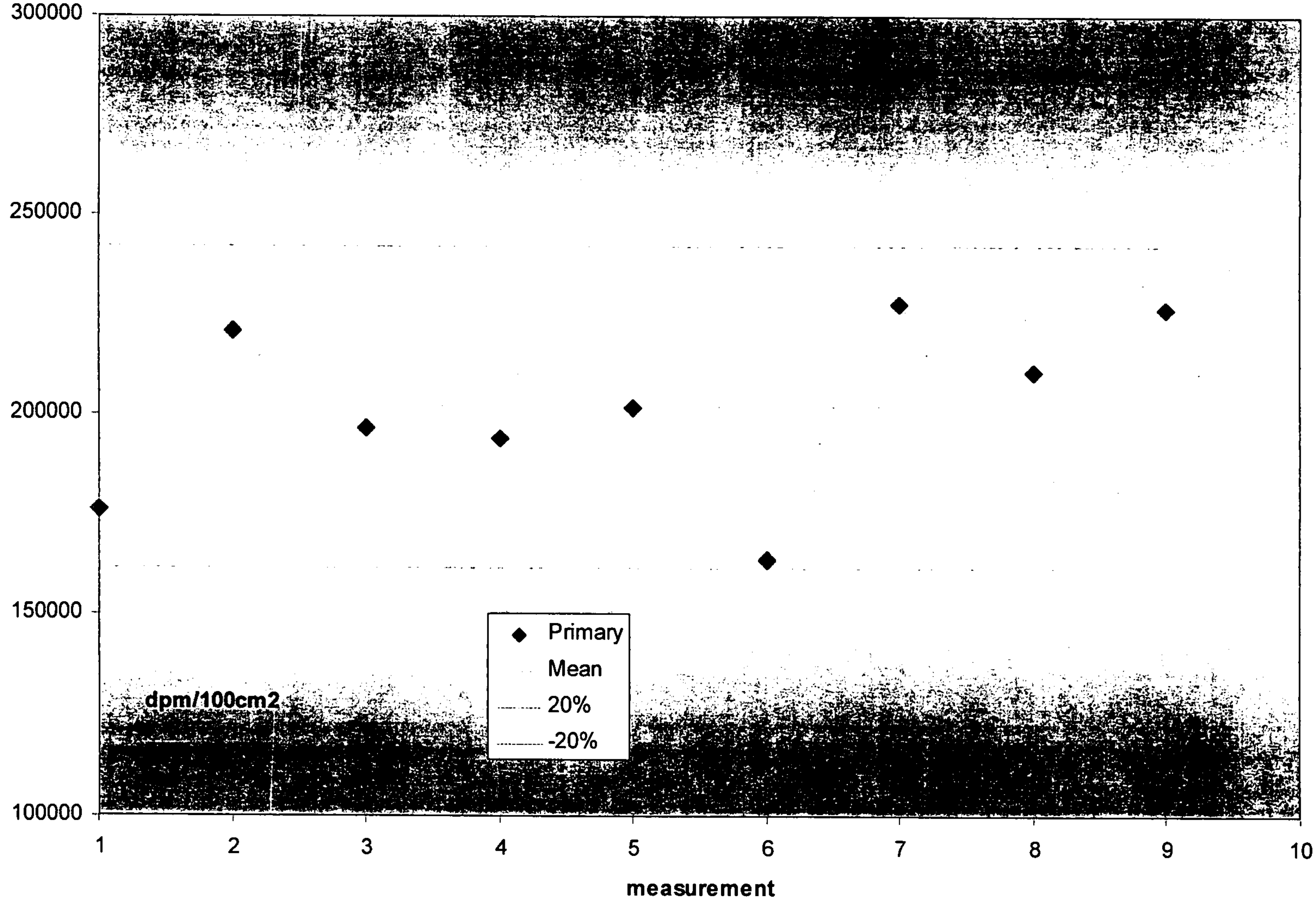
180cm Primary Detector Alpha Check Source Control Chart (S/N: SRA-018, SRA-016)
300000
250000
200000
150000
100000
dpm/100cm2
Primary
Mean
-20%
+20%
1
6
11
16
21
26
measurement

40

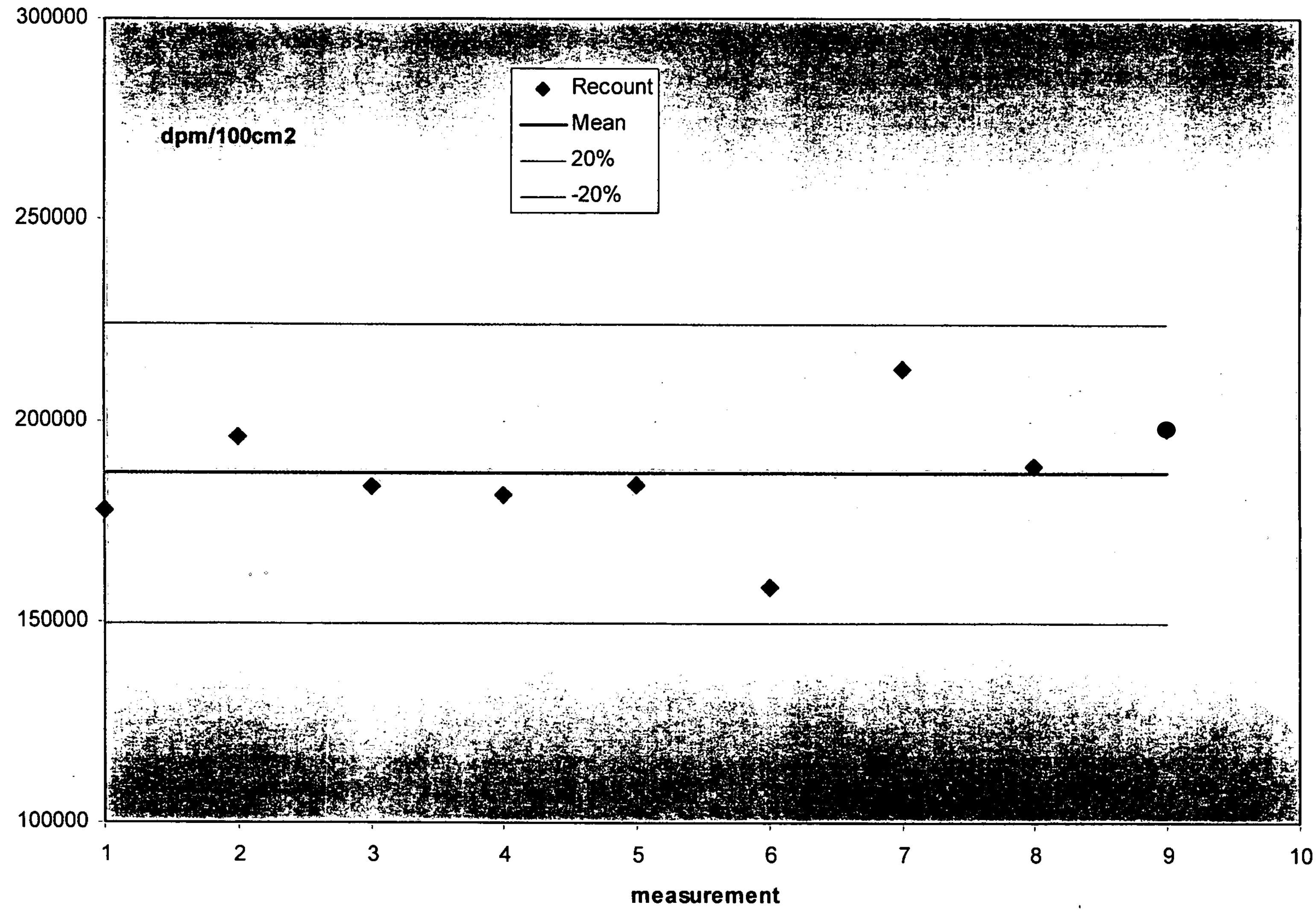
180cm Recount Detector Alpha Check Source Control Chart (S/N: SRA-018, SRA-016)



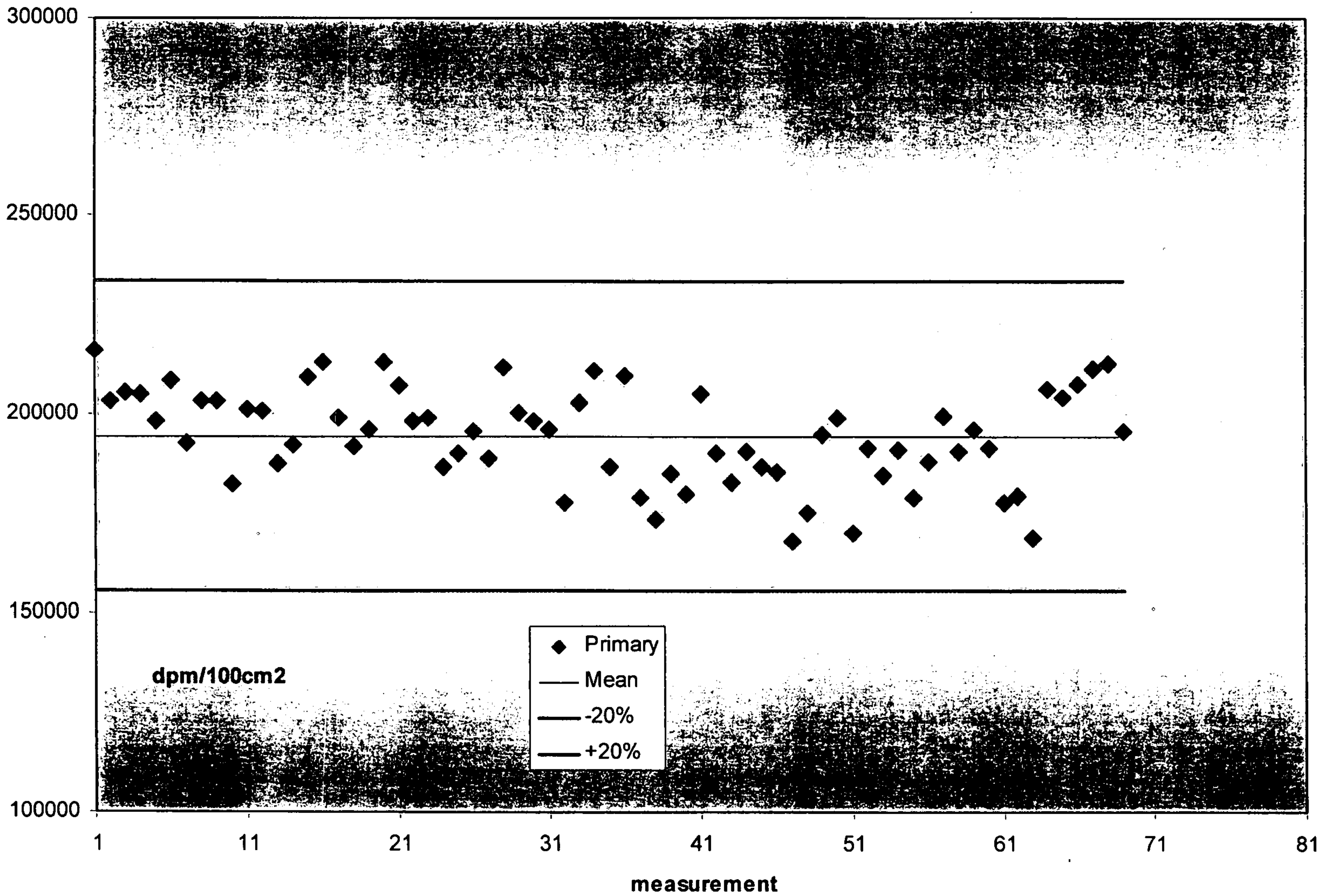
90cm Primary Detector Alpha Check Source Control Chart (S/N: SRA-011, SRA-010)



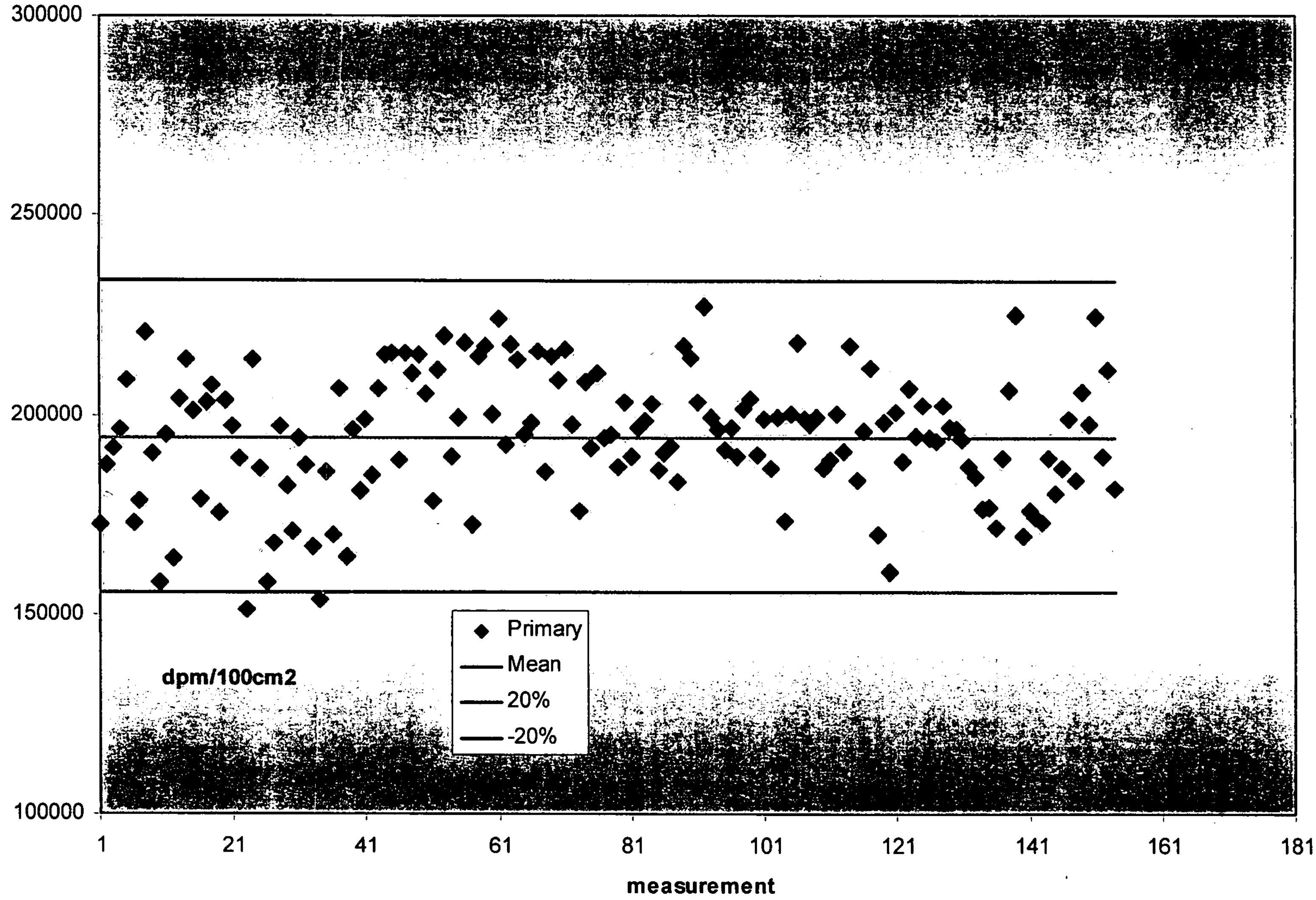
90cm Recount Detector Alpha Check Source Control Chart (S/N: SRA-011, SRA-010)



90cm Corner Detector Alpha Check Source Control Chart (S/N: SRA-C-001)



180cm Corner Detector Alpha Check Source Control Chart (S/N: SRA-C-005, SRA-C-003)



APPENDIX 3
Data Quality Assessment

DATA QUALITY ASSESSMENT

Data used in making management decisions for waste management remedial actions must be of adequate quality to support the decisions. Adequate data quality for decision-making is required by applicable RMRS and K-H corporate policies (RMRS, 1998, §6.4 and K-H, 1997, §7.1.4 and 7.2.2), as well as by the customer (DOE, RFFO; Order O 414.1, Quality Assurance, §4.b.(2)(b)). Regulators and the public also expect decisions and data that are technically and legally defensible. Verification and validation of the data ensure that data used in decisions resulting from the FSS are usable and defensible.

Verification and validation (V&V) of this CRSP are the primary components of the DQA. V&V constitutes the cornerstone of the DQA because statistical tests and background determinations relative to decision-making for radiological survey units were not implemented nor required per the approved CRSP for the 779 Cluster. Instead, measurement results were compared, on a one-to-one basis, with free-release criteria given in DOE Order 5400.5. The FSS results could, theoretically, be used to conduct Sign Tests for decisions, but because all individual measurements were less than the DCGLs, the survey units meet release criteria without further data reduction. The DQA presented in this Appendix supports conclusions in the report through implementation of the guidelines taken from the following MARSSIM sections:

- §4.9, Quality Control
- §8.2, Data Quality Assessment
- §9.0, Quality Assurance & Quality Control
- Appendix E, Assessment Phase of the Data Life Cycle
- Appendix N, Data Validation using Data Descriptors

VERIFICATION OF RESULTS

Verification ensures that data produced and used by the project are documented and traceable per quality requirements. Verification consisted of reviewing the project's data relative to three subsets: 1) radiological surveys for removable and total contamination, 2) scan surveys, and 3) radiochemical data resulting from samples taken and subsequently analyzed via alpha spectrometry. Verification confirmed that

- Chain-of-Custody was intact from initial sampling though transport and final analysis;
- preservation and hold-times were within tolerance
- format and content of the data are clearly presented relative to goals of the project, i.e., to determine, with at least 95% confidence, that the Survey Units of interest (Building 729) are adequate for radiological free release.

Verification of the Building 729 FSS data also confirmed Quality records representing implementation of the following quality controls:

- calibrations (radiochemistry & surveys), for accuracy
- laboratory control samples (LCS -- radiochemistry), for accuracy
- blanks (radiochemistry), for accuracy
- duplicate measurements (radiochemistry & surveys), for precision
- chemical yield (radiochemistry), for accuracy
- count times (radiochemistry & surveys), for sensitivity
- sensor efficiencies (radiochemistry & surveys), for accuracy
- sample preparations (radiochemistry), for accuracy, representativeness

In summary, the verification confirmed that documentation and quality records are intact for the project, which in turn corroborates implementation of the required technical quality controls and administrative requirements, particularly verification of those documents and records that will ultimately support the CERCLA Administrative Record. All relevant Quality records associated with the Building 729 D&D final status survey decisions will be submitted to the RMRS Records Center for permanent storage within 30 days of approval of the CRSR.

VALIDATION OF RESULTS

Validation consists of a technical review of all data that directly support the FSS decisions, so that any limitations of the data relative to project goals are delineated, and the associated data are qualified (caveated) accordingly. Data were validated relative to

1) the DQOs of the project as defined in the CRSP for the 779 Cluster (i.e., did the final data achieve the initial DQOs of the project?), and

2) quality criteria discussed throughout various sections in the MARSSIM (sections noted previously).

MARSSIM criteria for the broad topic of "data quality assessment" used in final status surveys generally falls within the generic categories of quality assurance, quality control, data validation, and data assessment (including verification and validation). Table A3-1 provides a "crosswalk" that lists the primary MARSSIM sections and generic data quality criteria (at top) and their corresponding implementation via the CRSP, CRSR, and project files.

All of the significant MARSSIM criteria listed in Table A3-1 are summarily discussed within the "PARCC Parameters" section. PARCC parameters are congruent with "data descriptors" in the MARSSIM parlance and address characteristics of the data that must be defined for scientific integrity and defensibility. The next section, which addresses the PARCC parameters -- Precision, Accuracy, Representativeness, Comparability, and Completeness, will also include discussion on bias and sensitivity, two more data descriptors emphasized in MARSSIM. With respect to the summary table (A3-1), note that at least one "X" in each column constitutes achievement of the MARSSIM quality objective (vs. one "X" in each row). The only MARSSIM component missed was that of formal documented oversight on the project. This disparity of at least one formal oversight report will be corrected for the Building 779 final status survey.

Validation of data to K-H contractual requirements (K-H Statements of Work is currently performed on a site-wide basis at ~25% frequency by the K-H Analytical Services Division. Satisfactory validation at this frequency indicates that subcontracted labs are operating competently relative to industry-wide standards, and more specifically, that sample custody and analytical procedures are implemented under defined quality controls on a sitewide programmatic basis. Sitewide data validation coupled with annual lab audits provides the inference that all analytical and radiochemical results not *specifically* validated, are represented by the percentage that is validated. Radiochemistry performed for this FSS were verified as meeting K-H contractual requirements -- Module RC01-B.3 for alpha spectrometry (4/24/98 and Module 9, 7/6/98).

PARCC Parameters

PRECISION

A general, or "robust", V&V of the project's reproducibility, relative to data reduction and decisions, is provided in Appendix 2.

Radiological Surveys

Precision of the radiological instrumentation was satisfactory based on tolerance charting of daily source measurements for each individual sensor used on the project, which includes all measurement types (scans and static measures for total contamination, swipes for removable). Adequate precision was established through instrument performance within a ±20% range as defined by measurement results compared to a standard source value. Based on standard protocol (*Radiological Safety Practices*) for hand-held survey devices, any measurement exceeding the defined tolerance limits required corrective action (repair or replacement) prior to the instrument's use in measurement of real samples. For the SIMS, three (3) measurements were taken for each QC check "episode" (Millennium QAP, 3/99); of the 3 measurements, 2 consecutive measurements had to pass specifications. This criterion has a probabilistic basis to accommodate occurrence of false positives and negatives inherent with all SIMS measurements, including the QC checks. Specifically, 2 consecutive measurements within tolerance significantly increase confidence (over just 1 measurement) that the instrument output is truly within tolerance (and not within tolerance just due to random chance).

Duplicate measurements were also periodically acquired (≥5% frequency of total surface activity surveys) on the MARSSIM survey grids; all duplicate measurements were within tolerance based on the acceptance criterion that both results be below $DCGL_W$.

Radiochemistry

Results from laboratory duplicates indicate adequate reproducibility based on duplicate results within statistical tolerance values (>90% confidence of equivalency between the original sample and the duplicate). Although blind duplicate samples were not acquired for determination of overall project precision, agreement between the multiple samples to within a range less than the $DCGL_W$ indicate that reproducibility is adequate for project decisions.

ACCURACY (and Bias)

Radiological Surveys

Accuracy of radiological surveys is satisfactory based on RFETS-programmatic annual calibrations that establish instrument efficiencies and sensitivities for all instrumentation used on this project. Daily source checks provided periodic checks to ensure that all sensors are within tolerance during daily operations. Performance check results were within the RFETS and industry-standard requirement of 20% of the applicable reference standard values. Full-scale multi-point calibrations provided accuracies of ±10% prior to implementation of survey instruments in the field, consistent with guidelines put forth in ANSI-N323.

Distance measurements recorded by the SCM/SIMS are within 3% of actual distances for mapping and location purposes.

Some potential biases were noted in control charts of the SCM system, specifically runs of data either above or below the standard reference values. However, given the overall low values of the data sets relative to the free-release criteria and low probability of false negatives, the potential bias(es) does not impact the ultimate project decisions of compliance with free-release criteria for the 3 survey units of interest. Potential low biases in recount results -- where recounts were performed with a handheld (Electra) instrument following elevated counts (above action, or investigation, levels) by the SCM -- have been concluded as not significantly biased, primarily based on the higher sensitivities of the handheld instrumentation, which would be expected to provide substantially lower results if contamination is, in fact, absent (i.e., false positives initially logged by the SCM). Comparability of these instruments, their results, and the role of measurement uncertainties in evaluating bias were addressed in responses to the regulators' comments and are summarized and documented in Appendix 5.

Radiochemistry

Accuracies of radiochemical results were within tolerance and acceptable based on the associated results of LCS and calibrations at the lab. Preparation blanks also confirmed that no significant cross-contamination occurred in the analysis process. Uncertainties of the radiochemical results are quantified for each sample by both 2-sigma error (probabilistic) and Total error (systematic + probabilistic). Uncertainties associated with the alpha-spec analyses were within standard industry magnitudes and did not adversely impact project decisions.

REPRESENTATIVENESS

Samples and surveys are representative based on the following criteria:

- familiarity with facilities -- multiple walk-downs and collaborations by and within the sampling team;
- implementation of industry-standard Chain-of-Custody protocols;
- compliance with sample preservation and hold times;
- documented and (site) approved methods:
  - radiochemistry - alpha spectrometry via K-H Module RC01-B.3 (4/24/98)
  - radiological surveys – 3-PRO-112-RSP-02.01
- compliance with the CRSP (RMRS, March 1999) -- reviewed & approved by technical and management consensus prior to implementation

COMPLETENESS

The data set for this project is complete, with respect to both samples acquired and associated quality records ("data packages") resulting from the characterization process. The following table summarizes the minimum required number of samples or surveys, the actual quantity of samples or surveys to date, and the remaining number of samples required for successful completion of the final status survey.

Rad Measurement Type	Required # of Samples/ Surveys	Actual # of Samples/ Surveys	Outstanding # of samples b/f completion	Comments
Survey Unit 72901				
Shonka: SCM/SIMS (total)	>10% areal coverage[2,3]	>>10% areal coverage[2,3]	0	DQO achieved
NE Electra (total)[1]	13	26	0	DQO achieved
Eberline SAC-4 and Tennelec: (removable)[1]	13	26	0	DQO achieved
Radiochemical	13	16	0	DQO achieved

Survey Unit 72902				
Shonka: SCM/SIMS (total)	>10% areal coverage[2,3]	>>10% areal coverage[2,3]	0	DQO achieved
NE Electra (total)[1]	13	16	0	DQO achieved
Eberline SAC-4 and Tennelec: (removable)[1]	13	18	0	DQO achieved
Radiochemical	13	16	0	DQO achieved
Survey Unit 72903				
'Shonka: SCM/SIMS (total)	>10% areal coverage[2,3]	>>10% areal coverage[2,3]	0	DQO achieved
NE Electra (total)[1]	13	17	0	DQO achieved
Eberline SAC-4 and Tennelec: (removable)[1]	13	19	0	DQO achieved
Radiochemical	13	17	0	DQO achieved

[1]see data summaries for additional "Post-media" surveys, i.e., following paint scrapes
[2]MARSSIM guidelines are 10% to 100% for Class 2 units; Radiological Engineering professional judgement (stated in the CRSP) yielded ~100% coverage for floors and walls to 2m height; 10% of remaining room surface areas.
[3]Required scan frequencies were verified and documented in the project history file.

Consistent with EPA's G-4 DQO process, the sampling design was optimized through back-calculating actual measurement results (acquired during final status survey) and comparing model output with original estimates. Use of actual sample- / survey (result) variances in MARSSIM's DQO model provided confirmation that an adequate number of samples/surveys had been acquired. Inputs required for decision-making, as stated in the original (planning) DQOs, were acquired, including coverage of originally-planned 3-dimensional boundaries of the structure. All radiological results are valid without qualification, and form data sets with adequate quantities and quality of data for free-release decisions on the three Survey Units of interest.

COMPARABILITY

All results presented are comparable with radiological survey and radiochemistry data on a site- and DOE-complex wide basis. This comparability is based on

- use of standardized engineering units in the reporting of measurement results
- use of site-approved procedures (RSPs)
- systematic quality controls
- thorough documentation of the planning, sampling/analysis process, and data reduction into formats designed for making decisions posed from the project's original data quality objectives.

SENSITIVITY

Adequate sensitivities, in units of dpm/100^2 cm, were attained for all surveys and radiochemical methods implemented based on MDAs below the transuranic DCGLs. Although all MDAs did not reach the MARSSIM goal of ≤50% DCGL, worst case sensitivities of measurement instrumentation did not exceed 60% DCGLs. Based on the high percentage of areas surveyed (scanned), accompanied by investigation of potential false positive scans, and in addition to the MARSSIM designed statistical measurements -- static surveys, swipes, and radiochemistry -- the slight decrease in the ideal minimum measurement sensitivity did not compromise survey unit decisions. The overall average and maximum measurement values across the survey units are relatively low enough, with respect to action levels, that the actual sensitivities did not compromise survey results. The nominal sensitivities for each survey and radiochemical method are summarized as follows:

- SCM/SIMS - scan surveys: < 155 dpm/100cm^2

- Surveys (Eberline SAC-4) - removable contamination: 4 $dpm/100cm^2$
- Surveys (NE Electra) - total contamination: 52 $dpm/100cm^2$
- Radiochemistry (alpha spec) - total contamination: <1 $dpm/100cm^2$

4.3.7 Summary

In summary, the data presented in this report have been verified and are qualified as valid and complete for comparison with free-release criteria (action levels) as stated in the original DQOs. All media sampled and surveyed, relative to both total and removable alpha activities, yielded results less than action levels for the associated contaminants of concern. Therefore, the Survey Units in question meet the free-release criteria with the confidences stated in this section and throughout the report.

OTHER QA ELEMENTS

All personnel performing quality-affecting activities within the FSS project were qualified to perform their specific tasks. Suitable training and qualification documentation for personnel performing the work, from the laborers to technical professionals to management, is documented in several ways. T&Q status for personnel is included in the *Building 779 Cluster Closure Project Health & Safety Plan* (Rev. 6, 18 August 1998) and personnel dossiers controlled by company-specific Human Resource departments.

APPENDIX 4

SCM/SIMS Scan MDC Evaluation

54

<u>MILLENNIUM SERVICES, INC.</u>

Leading the Way...

Determination of Minimum Detectable Concentration for One Square Meter Average Activity and Maximum 100 cm^2 Activity Using the SRA Surface Contamination Monitor/Survey Information Management System at the RFETS 779 Closure Project.

This document provides the technical basis for the determination of the Minimum Detectable Concentration (MDC) for one square meter average activity and maximum 100 cm^2 activity using the SRA Surface Contamination Monitor/Survey Information Management System (SCM/SIMS) at the RFETS 779 Closure project. The determination is based on performing surveys for alpha emitting radionuclides. For this project, radioactivity contribution from the construction media being monitored is included in the evaluation against the DCGLs, and is therefore not considered a factor in the background for the MDC evaluation.

Prepared by: Richard W. Dubiel Date: 28 April 99

Richard W. Dubiel, CHP

Introduction

Sensitivity is the *a priori* determination of the systems ability to detect radioactivity and a comparison of that level with performance goals. The instrument performance goals established for the 779 closure project final survey is that the instrument be able to detect 50% of the $DCGL_W$ (100 dpm/100 cm^2) and the $DCGL_{EMC}$ (300 dpm/100 cm^2). Performance is determined with the recognition that the values associated with naturally occurring radioactivity are not subtracted from the measured values and are considered in the total activity to be evaluated against the DCGLs. Therefore, the system performance evaluation does not need to include a determination of the level of radioactivity in excess of naturally occurring background, but only that level at which any radioactivity can be detected. The only background to be considered is the inherent instrument background.

Discussion

To determine the instrument background, several 1-minute counts were obtained with a ¼" hard particleboard shield over the face of the detector. The particleboard is expected to result in lower values relative to the construction media of building 729. A 180- cm. x 10-cm. detector and a 90-cm. x 10-cm. detector were used and integrated counts over the length of the detectors were obtained. The results obtained are shown in the following tables:

SCM Instrument Background Determination

180 cm. x 10 cm. Detector		90 cm. x 10 cm. Detector	
#	CPM	#	CPM
1	12	1	9
2	5	2	11
3	14	3	5
4	15	4	7
5	15	5	8
6	8	6	7
7	8	7	7
8	16	8	7
9	14	9	11
10	15	10	8
Mean	12.2	Mean	8.0
Std. Dev.	3.8	Std. Dev.	1.8

For the 180 cm. x 10 cm. detector, the instrument background was determined to be 12.2 counts per minute (cpm) over a 1800 cm^2 detector. The 12.2 cpm detector background also equates to an average instrument background of 4.5 counts in a one square meter equivalent survey. This is determined by multiplying the total counts observed in a one-minute interval by the number of seconds required to survey a one square meter area divided by 60. The instrument background was established as 12.2 counts in one minute

56

over a 1800 cm^2 detector surface. The SCM, surveying at 2.5 cm/sec, would survey a square meter in 22.2 seconds. Thus, the instrument background was calculated as 4.5 counts. Use of this inherent instrument background, and an average efficiency of 30% (mid-range for the detectors utilized) in the MDC formula presented in NUREG-1507 (section 3, Table 3.1, reference Strom & Stansbury 1992) results in *a priori* MDC values for a square meter of approximately 100 dpm. This value equates to an average of 1 dpm/100 cm^2. This value is below the instrument performance goal established for this survey.

Similarly, the instrument background for the 90 cm. x 10 cm. detector was determined to be 8.0 cpm. A one m^2 survey would result in an inherent instrument background of 5.9 counts. A 90 cm. x 10 cm. detector would complete the survey in 44.4 seconds. The efficiency of the 90 cm. x 10 cm. detectors range from 30% to 39%. The mid-range for the detectors utilized, 34.5% is used. The 34.5% efficiency and the stated background are used in the Strom & Stansbury MDC equation with a resultant MDC of 53.1 dpm. This value equates to an average of less than 1 dpm/100 cm^2.

The results provided are established for detectors operated in the encoder mode. Corner detectors would result in lower MDCs because they are used with longer count times, and because the efficiencies are higher than those for rolling detectors.

The attached spreadsheets use equation 1-1 (Strom & Stansbury) to determine MDC. For a detector background of 12.2 cpm for the 180 cm. x 10 cm. detector, and 8.0 cpm for the 90 cm. x 10 cm. detector, and a 30% detector efficiency. The count time of 22.2 seconds for the 180 cm. x 10 cm. detector yields a square meter MDC of 100.7 dpm. This equates to a 100 cm^2 average over the square meter of 1.007 dpm. The count time of 44.4 seconds for the 90 cm. x 10 cm. detector yields a square meter MDC of 53.1 dpm. This equates to a 100 cm^2 average over the square meter of 0.531 dpm.

$$MDC = \frac{3 + 3.29\sqrt{R_b t_g (1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)} \qquad (1\text{-}1)$$

where:

R_b	=	background count rate
t_g	=	gross count time
t_b	=	background count time

Field survey results confirm that the inherent instrument background was well below the total counts accumulated during actual surveys of painted concrete surfaces within building 729 (approximately 300 counts in a one m^2 area). The measured value on uncontaminated painted concrete surfaces equated to an activity level of 10 dpm/100 cm^2 averaged over a square meter. This is well above the detection limit and shows that the system is responding to natural radioactivity in the surface or fallout bearing radon progeny (dust) on the surface.

Analysis of expected values from naturally-occurring radioactive materials in various surfaces at the Rocky Flats Environmental Technology Site (RFETS) indicates that a mean value of 10 to 20 dpm/100 cm^2 on painted concrete surfaces can be expected. This site data is based on measurements obtained at various non-impacted site buildings including buildings 111, 112, and 443. Evaluation of the data obtained from surveys within building 123 and reported in the final survey report also show actual measurements with an average 100 cm^2 activity over 1 m^2 areas of approximately 10 dpm. The measured values are consistent with those reported for concrete in NUREG 1507, Section 5.3.2. This data provides further evidence that SCM/SIMS reported measurements of average one m^2 values of approximately 10 dpm/100cm^2 are valid measurements.

Therefore, the values measured provide true indication of the SCM/SIMS sensitivity and average 1 m^2 sensitivity of less than 10 dpm/100 cm^2 can be asserted. This value establishes that SCM/SIMS can detect radioactivity at the naturally occurring radioactivity level. This value is well below 50% of the $DCGL_W$, the system sensitivity required for this survey. The asserted sensitivity is consistent with that established in the Technical Basis Document developed and approved at RFETS for the use of SCM/SIMS as a final survey instrument for building 123 ("Qualification of SRA/Millennium Services, Inc. Data for Use in Building 123 Final Survey" – RLM-004-98).

Evaluation of SCM/SIMS sensitivity against the survey performance goal of 50% of the $DCGL_{EMC}$ can be performed in a similar manner (refer to equation 1-1). Since only inherent instrument background is considered when determining the MDC, the backgrounds determined with particle board placed over the detector can be applied. The 180 cm. x 10 cm. detector background for any 100 cm^2 area is 12.2 cpm/18 = 0.677 cpm. Eighteen represents the number of 100 cm^2 areas in the probe area. For the 90 cm. x 10 cm. detector, the background is 8.0 cpm/9 = 0.889 cpm (nine represents the number of 100cm^2 areas in the probe area). These background values and the detector efficiency of 30% are used in the Strom & Stansbury MDC equation, with results again highlighted in the attached spreadsheets. The appropriate count time for either size detector is 4 seconds for the SCM used in the encoder (rolling) mode, and 8 seconds for the timer (corner detector) mode. The resultant maximum 100 cm^2 MDCs are:

180 cm. x 10 cm. 4 second rolling	186.1 dpm/100 cm^2
90 cm. x 10 cm. 4 second rolling	166.4 dpm/100 cm^2
180 cm. x 10 cm. 8 second corner	101.3 dpm/100 cm^2
90 cm. x 10 cm. 8 second corner	91.4 dpm/100 cm^2

The MDCs for detectors used in the encoder (rolling) mode range from 55% to 65% of the instrument performance goal for the $DCGL_{EMC}$. The SCM/SIMS used in the encoder mode includes a recount detector that performs a second survey of the area. Although this data is normally not averaged with the primary detector unless areas of specific interest are identified, the recount data provides opportunities to reduce the MDC if necessary. The MDCs for detectors used in the encoder mode are below the 225 dpm/100 cm^2

criteria for field investigation and therefore supports field activity requirements. Detectors used in the timer mode, with the preset 8 second count time for alpha surveys at the 779 closure project meet the performance goal of 50% of the $DCGL_{EMC}$.

Conclusion

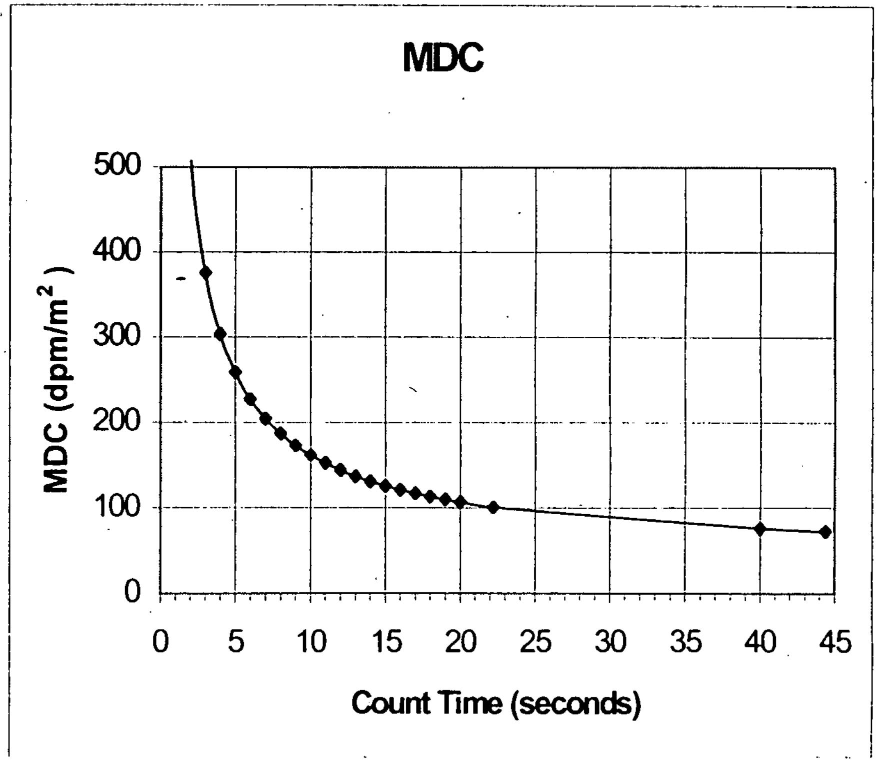
SCM/SIMS exceeds the instrument performance goal for $DCGL_W$ for final surveys of 779 closure project final survey, i.e. 50% of the $DCGL_W$. The $DCGL_{EMC}$ goal is also met for detectors used in the timer (corner) mode. Both the primary and recount detector of the assembly used in the encoder (rolling) mode show the *a priori* MDC slightly above the goal, but below the 75% of $DCGL_{EMC}$ value established for field investigations. Combination of primary and recount data could reduce the MDC below the goal, however no field benefit would be recognized.

Table 1.0

MDC Determination for 180 cm Detector (1 m^2 Average)

efficiency =	30.0%
bkg (cps) =	0.203
bkg (cpm) =	12.2

bkg ct. time (m)	Count Time (s)	Count Time (m)	95% MDC dpm	67% MDC dpm
1	1	0.017	899.2	680.0
	2	0.033	513.3	357.0
	3	0.05	375.5	246.9
	4	0.067	303.2	191.0
	5	0.083	258.1	156.9
	6	0.1	227.0	134.0
	7	0.117	204.2	117.4
	8	0.133	186.7	104.9
	9	0.15	172.7	95.0
	10	0.167	161.3	87.1
	11	0.183	151.9	80.6
	12	0.2	143.8	75.1
	13	0.217	136.9	70.4
	14	0.233	130.9	66.4
	15	0.25	125.7	62.9
	16	0.267	121.0	59.8
	17	0.283	116.8	57.1
	18	0.3	113.1	54.7
	19	0.317	109.7	52.5
	20	0.333	106.6	50.5
	22.22	**0.37**	**100.7**	**46.7**
	40	0.667	75.6	31.2
	44.4	0.74	72.3	29.2



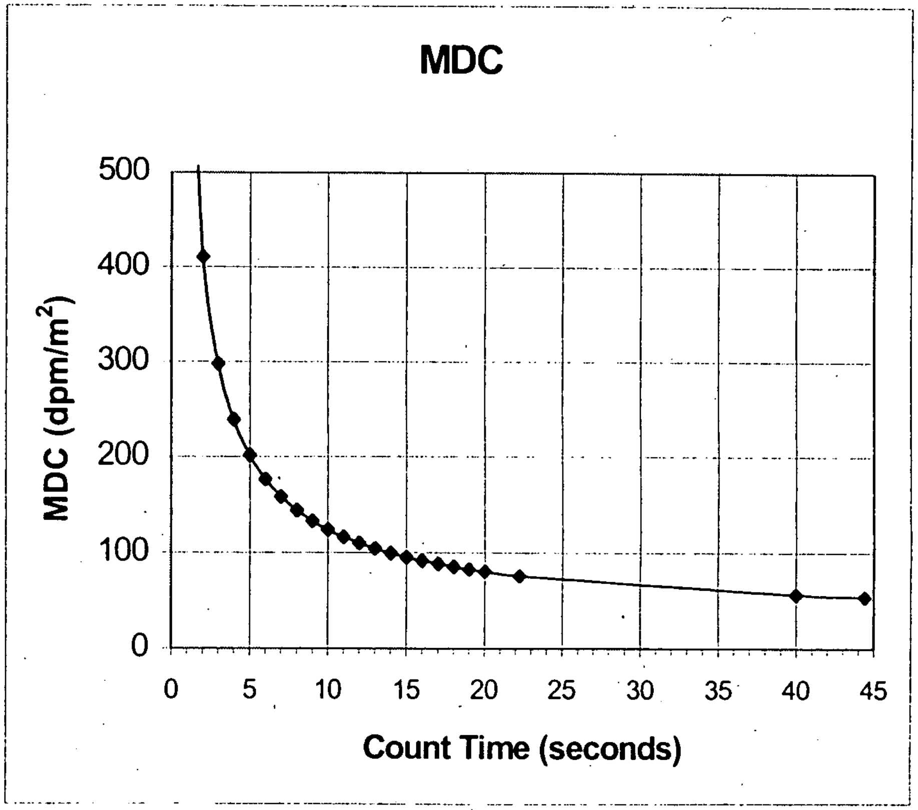
Note: 100.7 dpm over the surface area monitored (1 m^2) equates to 1.007 dpm/100 cm^2 averaged over 1 m^2

Table 2.

MDC Determination for 90 cm Detector (1 m^2 Average)

efficiency =	0.345
bkg (cps) =	0.133
bkg (cpm) =	8

bkg ct. time (m)	Count Time (s)	Count Time (m)	95% MDC dpm	67% MDC dpm
1	1	0.017	732.4	578.1
	2	0.033	411.0	301.0
	3	0.050	297.5	207.0
	4	0.067	238.3	159.3
	5	0.083	201.6	130.4
	6	0.100	176.4	110.9
	7	0.117	158.0	96.8
	8	0.133	143.9	86.2
	9	0.150	132.7	77.9
	10	0.167	123.5	71.3
	11	0.183	116.0	65.8
	12	0.200	109.5	61.1
	13	0.217	104.1	57.2
	14	0.233	99.3	53.9
	15	0.250	95.1	50.9
	16	0.267	91.4	48.3
	17	0.283	88.1	46.0
	18	0.300	85.1	44.0
	19	0.317	82.5	42.2
	20	0.333	80.0	40.5
	22.22	0.370	75.4	37.4
	40	0.667	55.7	24.4
	44.4	**0.740**	**53.1**	**22.8**



Note: 53.1 dpm over the surface area monitored (1 m^2) equates to 0.531 dpm/100 cm2 averaged over 1 m^2

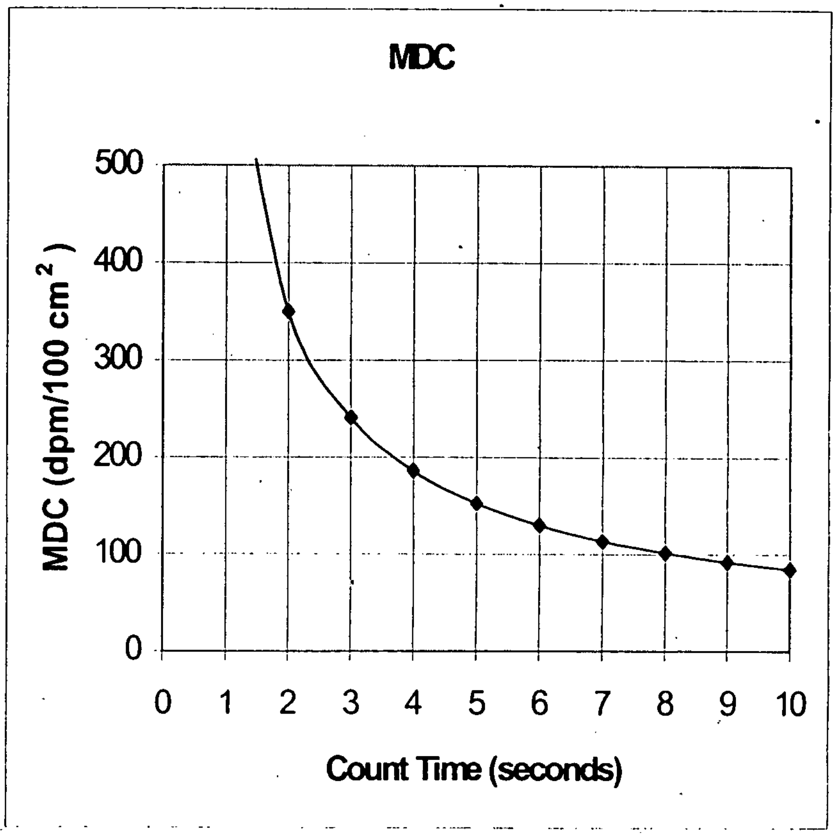
61

Table 3.0

MDC Determination for 180 cm Detector (100cm^2 Maximum)

efficiency = 0.30
bkg (cps) = 0.011
bkg (cpm) = 0.677

bkg ct. time (m)	Count Time (s)	Count Time (m)	95% MDC dpm	67% MDC dpm
1	1	0.01667	670.5	618.8
	2	0.03333	350.2	313.4
	3	0.05	241.4	211.1
	4	**0.06667**	**186.1**	**159.7**
	5	0.08333	152.5	128.7
	6	0.1	129.9	108.0
	7	0.11667	113.6	93.2
	8	**0.13333**	**101.3**	**82.0**
	9	0.15	91.7	73.3
	10	0.16667	83.9	66.4
	11	0.18333	77.5	60.7
	12	0.2	72.1	55.9
	13	0.21667	67.5	51.9
	14	0.23333	63.6	48.4
	15	0.25	60.2	45.4
	16	0.26667	57.2	42.8
	17	0.28333	54.5	40.4
	18	0.3	52.1	38.4
	19	0.31667	50.0	36.5
	20	0.33333	48.0	34.8
	22.22	0.37033	44.4	31.6
	40	0.66667	29.3	18.8
	44.4	0.74	27.4	17.2



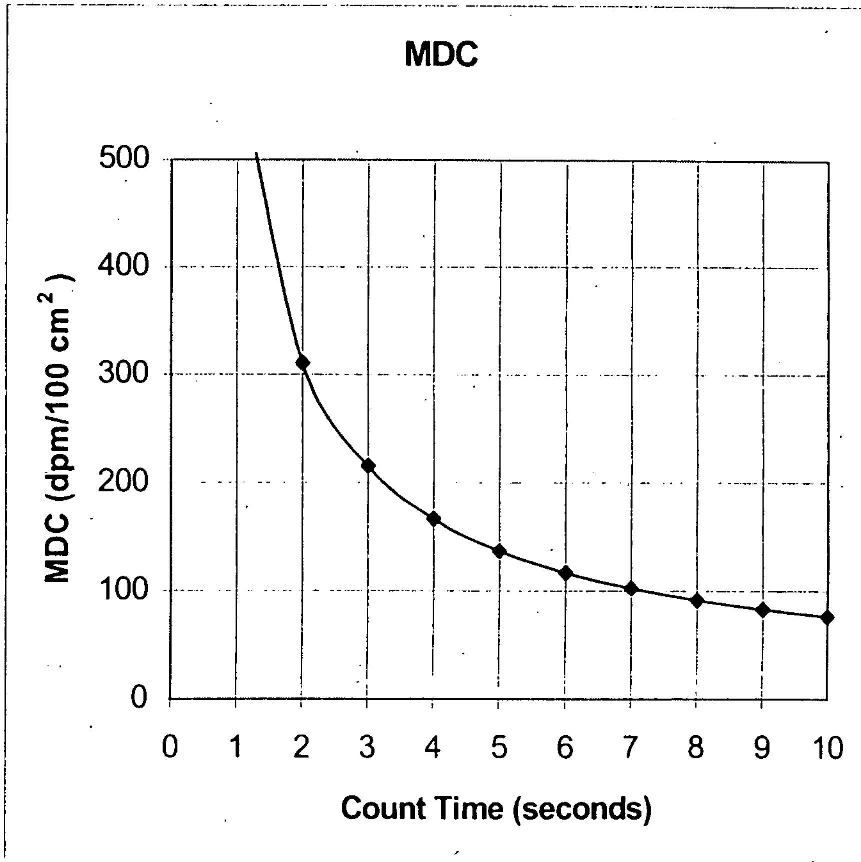
62

Table 4.0

MDC Determination for 90 cm Detector (100 cm^2 Maximum)

efficiency = 34.5%
bkg (cps) = 0.015
bkg (cpm) = 0.889

bkg ct. time (m)	Count Time (s)	Count Time (m)	95% MDC dpm	67% MDC dpm
1	1	0.01667	592.0	540.5
	2	0.03333	310.9	274.3
	3	0.05	215.1	184.9
	4	**0.06667**	**166.4**	**140.1**
	5	0.08333	136.8	113.0
	6	0.1	116.8	94.9
	7	0.11667	102.4	82.0
	8	**0.13333**	**91.4**	**72.2**
	9	0.15	82.9	64.6
	10	0.16667	76.0	58.5
	11	0.18333	70.3	53.5
	12	0.2	65.5	49.4
	13	0.21667	61.4	45.8
	14	0.23333	57.9	42.8
	15	0.25	54.9	40.2
	16	0.26667	52.2	37.8
	17	0.28333	49.8	35.8
	18	0.3	47.7	34.0
	19	0.31667	45.8	32.4
	20	0.33333	44.1	30.9
	22.22	0.37033	40.8	28.1
	40	0.66667	27.3	16.8
	44.4	0.74	25.5	15.4



63

APPENDIX 5

B 779 Final Status Survey Meeting Minutes (6/30/99)
Resolution of CDPHE/EPA/IVC Comments

64

Roberts, Sarah

From: Grube, Mike
Sent: Friday, July 09, 1999 11:53 AM
To: Roberts, Sarah
Subject: FW: B779 Final Status Survey Meeting Minutes

-----Original Message-----
From: **Whiting, John**
Sent: Friday, July 02, 1999 10:50 AM
To: Kray, Edd; Nickless, David; Daniels, Kevin; Barroso, Jeff; Grube, Mike; Roberts, Sarah; 'Mark Aguilar'; 'graham, richard'
Cc: Archibald, Jim; Mathis, Brian; Parker, Alan; Crowe, Steve; Parsons, Duane
Subject: B779 Final Status Survey Meeting Minutes

Attached are the minutes from the June 30, 1999 meeting. As stated in the attached agenda, the meeting was held to resolve remaining issues and reach concurrence on the path forward for conducting the Final Rad Survey for the remaining 779 Cluster. These minutes formalize the agreements reached at the meeting on issue resolution and document that concurrence was reached on the path forward.

Final Survey Meeting Minutes (...

65

B779 Final Status Survey Meeting
Resolution of CDPHE/EPA/IVC Comments
Date: 6/30/99

Attendees: E. Kray (CDPHE)
M. Agular (EPA)
R. Graham (EPA)
J. Lively (IVC)
D. Nickless (DOE)
J. Whiting (K-H)
K. Daniels (K-H)
J. Barroso (RMRS)
M. Grube (RMRS)
S. Roberts (RMRS)

Topics of Discussion: (See attachment #1, meeting Agenda)

1. CDPHE/EPA presented with a position statement pertaining to utilizing the SCM to demonstrate compliance with the $DCGL_W$, and the consideration of surface degradation factors during final status survey (see Attachment 2). The CDPHE, EPA, and IVC concurred with the resolutions provided in the position statement.
2. The final survey team provided a document that describes the data reduction methods performed by the SCM/SIMS in response to a request from Edd Kray (Attachment 3).
3. The EPA asked the final survey team to provide data demonstrating the detection capabilities of the SCM/SIMS. The final survey team provided two documents that described the calculation method to estimate probabilities of detection (Attachment 4) and actual data for comparison of the comparability of measurements collected from the SCM versus typical hand-held instruments (Attachment 5). The EPA and CDPHE were satisfied with documentation and the issue is considered resolved.
4. The CDPHE questioned the use of the 100 dpm/100 cm^2 average (per 5400.5) for a square meter. The K-H and final survey team explained the DOE's interpretation of the regulation.
5. Upon completion of the meeting, a request was made by EPA (Mark Agular) that all parties agree on the resolutions provided. All parties were in agreement that the tabled items were resolved and that the position statement contained in item 1.) above contained the agreed upon path forward for conduct of the Final Rad Survey for the remaining 779 Cluster.

Attachments
CC:
Attendees

66

T. Dieter
M. Hickman

67

Attachment 1
Meeting Agenda

68

779 Cluster Final Rad Survey
Meeting Agenda
RFFO, CDPHE and EPA
June 30, 1999

Meeting Purpose:
To resolve remaining issues on the conduct of the Final Radiation Survey for the remainder of the 779 Cluster and reach concurrence on the path forward for completing the survey.

- Resolution of IVC Issues

- Resolution of CDPHE/EPA Quality Assurance Issues
  - Data Averaging using the SCM System
  - Precision of SCM System
  - Comparability of SCM and Electra's

- Discussion and Concurrence on path forward

6A

Attachment 2

Resolution of Mactech IVC Team Concerns about the use of Shonka Contamination Monitors (SCM) for Final Surveys

10

KAISER • HILL
COMPANY

INTEROFFICE MEMORANDUM

DATE: June 30, 1999

TO: Brian Mathis

FROM: John Whiting, D&D Programs, Building 130, X7592

SUBJECT: RESOLUTION OF MACTEC IVC TEAM CONCERNS ABOUT THE USE OF SHONKA CONTAMINATION MONITORS (SCM) FOR FINAL SURVEYS - JWW-006-99

The IVC Team had several concerns with the use of SCMs as the sole method of determining a building is free of contamination at a 95% confidence level. On June 28 and June 29, 1999 meetings were held with the IVC Team to resolve these concerns. This memorandum documents the results of those meetings and the resolutions agreed to by the IVC Team, RMRS 779 project, and Kaiser-Hill representatives.

ISSUE #1: The Independent Verification Review Team for Building 779 final radiological surveys questioned whether or not it would be appropriate to apply a surface degradation correction factor when surveying for contamination.

DISCUSSION: Dust, dirt, oil, grease, water, and uneven or porous surface conditions are known to decrease the efficiency of measurement systems. Current methods utilized throughout the DOE complex rely on cleaning up the surface material (dust, dirt, oil, water, etc) and then ensuring that surveys are performed such that the instrument probe to survey surface distance is within the minimum distance required by the instrument specifications.

There are no established methods or requirements to utilize surface degradation correction factors at RFETS. Additionally, if surface degradation factors were to be required, they would have to be made specific to the actual conditions at each survey location, or a technical basis would have to be established to allow the use of a general correction factor for each type of material.

CONCLUSION: No surface degradation correction factors will be used for final surveys performed at for the B779 Cluster.

BASIS:

There is no requirement to utilize or technical basis to establish surface degradation correction factor. Current DOE requirements and instrument calibrations are based on surface activity measurements without regard to surface porosity

71

The final survey process requires all areas to be thoroughly vacuumed and all liquid/oil removed prior to performance of final surveys.

A statistical number of surface media samples are obtained at each painted total surface activity measurement location. These samples account for attenuated or absorbed activity.

There is no known migration method where significant levels of contamination would be absorbed in to the material being surveyed (mainly concrete) without also leaving contaminants on or near the surface to be detected.

Total activity measurements are obtained to release the areas being surveyed in accordance with MARSSIM as calculated to a 95% confidence level.

For future survey measurements, the total alpha activity count time for direct static measurements obtained with the N.E. Electra will be extended to a minimum of 90 seconds to provide greater assurance that instrument MDAs are at 50% of the DCGL or less.

Investigations of measurements exceeding 75% of the $DCGL_{EMC}$ are investigated with the N.E. Electra, which has a lower MDA than the Millennium System for discrete 100 cm^2 measurements.

ISSUE #2: Whether or not scanning with SCM equipment could be used as the sole method for determining an area had no average activity exceeding 100 dpm/100 cm^2as calculated to a 95% confidence level.

Discussion: The IVC Team considered scanning, including the use of the SCM to be a valuable tool for identification of elevated activity, but had concerns over the ability of the SCM to quantify amounts of radioactivity at level near background. For final surveys performed for Building 729, to increase the confidence level in assuring compliance with the release criterion, the final survey team agreed to perform investigations at levels below the applicable DCGL. The project performed all investigations at 75% of the $DCGL_{EMC}$ for all final survey units within the Building 729. Additionally, the project performed fixed point measurements at randomly selected locations in accordance with MARSSIM to show compliance with release criteria at a 95% confidence level.

CONCLUSION:

The B779 project will continue to perform investigations at 75% as specified in addition to the total activity measurements taken in accordance with MARSSIM to provide adequate confidence of the survey measurements obtained. All final surveys performed to date and all future surveys will meet the Data Quality Objectives delineated in the B779 Closeout Radiological Plan.

BASIS:

The performance of investigations is delineated in the Closeout Radiological Survey Plan. This plan requires an investigation at 75% of the applicable DCGLs for Class 3 areas, and investigations at 100% of the applicable DCGLs for Class 1 and 2 areas. The project will continue to perform investigations of scan survey results at 75% of the applicable DCGL. These

72

investigations will be performed with instrumentation that have a minimum detectable activity of 50% of the DCGL or less.

The total activity measurements will be obtained in accordance with MARSSIM as calculated to a 95% confidence level.

kjs

Concurrence:

RMRS 779 Project:

__(Signed copy on file)________________________________
Tom Dieter

MACTEC IVC Team:

__(Signed copy on file)________________________________
Jeff Lively

K-H Representative:

__(Signed copy on file)________________________________
Kevin Daniels

cc:
Jim Archibald
Jeff Barroso
Steve Crowe

Kevin Daniels
Tim Hedahl
Jeff Lively
Alan Parker
Kelly Trice
Terry Vaughn

Attachment 3

Data Processing for SCM/SIMS System
(Data Averaging)

74

MILLENNIUM SERVICES, INC.

Leading the way...

Mr. Mike Grube
Radiological Engineer
Rocky Mountain Remediation Services
Rocky Flats Environmental Tech Site
State Hwy. 93 and Cactus
Golden, CO 80402

Dear Mike:

The attached document is provided in response to Mr. Edd Kray's request to view the data processing used within SIMS to determine average contamination in a one square meter area. We have chosen a sample grid from a survey performed at the EPA laboratory in Montgomery, Alabama. The choice of this specific grid allows the reader to also recognize the traps associated with performing a few measurements with longer count times, then statisically evaluating the area based on those measurements.

I hope that this data and explanation are of value and answer Mr. Kray's request. Please contact me if there are any additional questions, or if further clarification is needed.

Sincerely,

MILLENNIUM SERVICES, INC.

Richard W. Dubiel, CHP
Vice President

75

The survey of the EPA Dosing Building in Montgomery, Alabama was performed by Shonka Research Associates, Inc. (SRA) for the EPA in 1995 to assist in resolving a dispute with the D&D contractor. The data is from a beta survey, and likely sources of contamination include ^{90}Sr and ^{226}Ra with their daughter product radiations, based on historical records from the facility. The main contamination visible in the image came from insects (cockroaches) that traveled from above the ceiling of the room to a drain in the center of the room along a floor crack for water, and returned along the crack in the floor. As the insects returned, they tracked contamination from the drain along their pathway. The survey also shows contamination from spills around former lab sinks and from inadequate cleanup around a source storage safe. An automatically generated survey report for the entire room's floor is provided as an attachment to this document. The survey greatly assisted the EPA, and Jim Kitchens (US EPA-ERD, phone (706) 355-8043) who is the radiation safety officer for the EPA can discuss the survey and results. The SCM/SIMS received a favorable review from the EPA staff that were involved as a result of this survey.

A sample grid, grid 4,2 in the room was extracted from the data set. The data includes the floor drain, and the hot area is from beta activity on the surface of the drain tile that extends into the floor. The SCM records the contamination from the surface in 5 cm by 5 cm areas that SRA calls "pixels" because of their use in the SIMS image analysis system. This pixel corresponds (roughly) to the area of a pancake GM probe, and the data is similar to the data one would get from a short count with a GM, except for slightly different sensitivity due to differences in the radiation detector's entrance window, which is much thicker on the GM. A spreadsheet called "Raw 25 cm^2 Data" is provided in Excel format the has the 400 measurements in the grid 4,2 square meter. The spreadsheet also includes an extra row of 25 cm^2 pixels along the right hand side and bottom edge that are used in determination of the maximum 100 cm^2 data. This will be discussed later. The 2 dimensional colorgraphic image shown below is of the 400 data points in the grid 4,2 square meter. The data was taken at 2"/second scan speed rather than the 0.8"/second used in Building 729 at RFETS. Each pixel represents a one second count time.

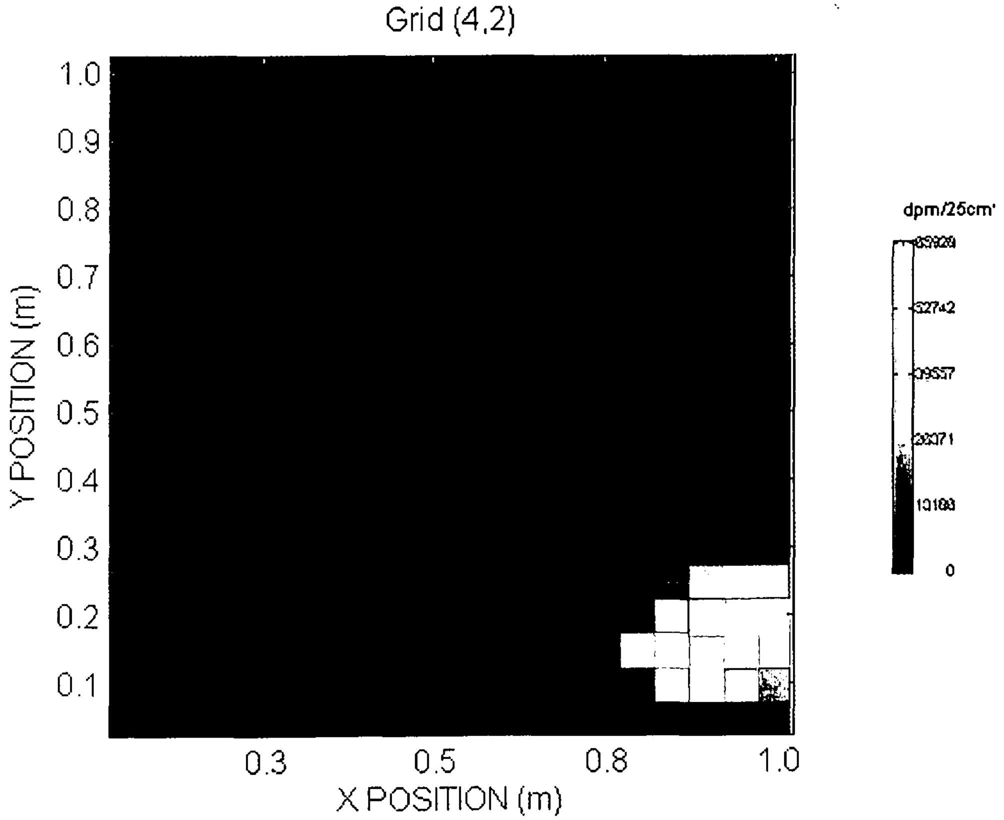


Figure 1 Image Plot of 25 cm^2 data in Meter Grid (4,2)

A copy of the spreadsheet is presented on the next page. The actual Excel spreadsheet is attached to this correspondence, to allow any reader to independently confirm the math. The extra bottom row on the spreadsheet labeled "Max" uses the excel function to select the maximum value in the column of data above it.

Raw 25 cm^2 Data

712	785	980	497	952	915	1390	457	1406	229	958	1957	723	721	733	1695	1560	96	730	457	0
704	651	584	657	584	584	883	1032	1167	1048	1244	584	655	458	1225	551	805	872	272	778	0
515	0	515	1041	258	527	1267	1031	520	1031	258	773	1039	779	515	1049	515	450	272	534	755
765	1307	1303	782	1834	790	1564	1558	2349	1834	782	782	1043	524	513	782	416	96	533	261	252
514	780	1036	777	524	0	1036	518	1036	777	1554	518	1295	518	1029	777	726	96	0	526	0
0	1337	535	802	800	267	1604	535	2139	802	802	1070	1337	535	535	0	267	1070	267	0	0
565	3955	1695	0	1695	0	2825	3955	3390	1695	1695	1695	1695	1130	0	0	1130	2260	2825	0	0
1076	1615	2691	1076	538	1615	1615	1615	1615	538	538	2691	2153	2691	0	1615	1076	0	0	0	0
0	1611	1074	1074	2685	1611	6982	1611	4834	537	537	0	0	537	2685	1611	0	0	0	537	0
2804	4406	3877	5057	5080	5256	11256	6919	4398	4820	5164	4659	5946	3563	3578	4138	2452	2544	2789	1440	337
532	2662	3195	3727	2130	532	1065	3195	2130	2662	1597	1597	3195	2130	2130	2130	1597	2130	1597	1065	0
700	3501	2801	700	1401	1401	1401	2101	2801	1401	2101	700	1401	3501	2101	700	700	2101	2101	3501	0
525	1576	1576	525	1576	1050	1050	2101	3676	2626	2101	3151	3151	3151	2626	2101	3151	5252	7353	2626	525
3933	5039	3925	2516	5507	5281	4845	2976	3747	3218	2976	1885	787	904	2260	5877	5425	5877	4069	1356	0
1063	1065	1279	1277	2976	2334	2770	1707	1700	3195	1065	1491	854	1712	2568	8134	10702	9846	6421	7705	1284
216	2682	1298	2857	1081	1557	2424	1601	1817	2815	3031	2295	476	2079	5198	10915	16112	30146	35343	31705	4678
875	1116	1650	1333	1116	1333	2791	1700	4008	2575	2233	2283	4059	4959	17503	18086	29172	65928	54842	52509	4084
1059	3485	2234	2503	1425	2658	809	1117	3275	3949	4566	4758	4566	6165	17879	34525	40691	50555	57337	45623	3083
1064	2853	1913	2210	2507	2548	2845	2887	6449	5600	3992	3860	4412	5344	17221	19002	32067	44537	36817	23753	594
1267	3834	1029	2793	2545	3574	3042	3754	3245	5235	3743	4489	5235	4229	9453	14428	14925	10945	8458	9453	995
1634	1508	2388	880	3396	3647	2012	2012	2517	6167	2895	2264	3524	3021	9063	3776	11329	6042	3021	6798	755

Additional Pixels from adjacent grids used by 2x2 summing filter to assess 100 cm^2 areas at edge boundary

Mean: 15936 *

* Average of all 25 cm^2 pixels in the grid multiplied by 4 to convert to 100 cm^2 Area

This data is provided to demonstrate the way SIMS computes the average, and to provide a sample meter grid in Excel spreadsheet format to allow others to independently confirm that the average result is the same no matter how the average is calculated.

In SIMS the data shown in the spreadsheet called "Raw 25 cm^2 Data" is summed into 100 cm^2 pixels by adding four adjacent 25 cm^2 pixels together at a time. The extra (21^{st}) row and column that was mentioned above are not used to determine the average. We have also provided this sum in the sheet labeled "100 cm^2 pixels". The result is shown in 10 columns by 10 rows. When we average either the 400 pixels in spreadsheet ("Raw 25 cm^2 Data") or the 100 pixels in spreadsheet ("100 cm^2 pixels"), correcting for area, the value we get is 15,936 regardless of how we perform the summation. This is the same answer that can be seen in the attached autogenerated report for meter 4,2. (slight differences in the last digit are due to differences in rounding numbers) Our answer can also be obtained by using the standard function in Excel called "Average(insert the cell reference range here)".

Also shown is the standard deviation. The standard deviation expresses how variable the data is. The standard deviation for grid (4,2) is 31924 dpm/100 cm^2. Note that the standard deviation is approximately 200% of the mean, since the grid contains a small area of high contamination The standard error, which is the standard deviation divided by the square root of the number of observations (divide by sqrt(400) = divide by 20) is an expression of how well the average known. The standard error for grid (4,2) is 1596 dpm/100 cm^2. The standard error is approximately 10% of the mean for the grid. If you re-measured the same meter, taking great care to keep everything constant, then 68.3% of the time, the average would fall between our asserted average plus or minus one standard error. Meter grids without localized hot spots would have both standard deviations and standard errors that would be a much smaller percentage of the mean value. To summarize, the standard deviation is a range that an additional measurement would be expected to be within 68.3% of the time, and the standard error is a range that the average of all measurements would be expected to be within 68.3% of the time if all of the measurements were repeated.

With traditional hand-held instruments, a meter is often characterized by taking 5 each, 100 cm^2 measurements with a one minute count time. This measure only 5% of the area (5 each out of a total of 100 each, 100 cm^2 areas); with a total count time of 5 minutes (300 seconds). The SCM, when operated at 0.8"/sec (as was the case in Building 729) records 400 (25 cm^2) measurements with a total of 984 seconds of count time. The SCM is roughly twice as precise as hand-held instrumentation taking 5 one minute measurements, and this is only when the meter has roughly constant readings everywhere on it. When the meter has areas of high contamination (such as in the example meter), the SCM method is much more accurate and precise than hand-held instrumentation, since it measures everything. Hand-held instruments, which are used to measure only 5% of the area, can miss the hot spot and get the wrong number. The only logic that can be used to argue that the SCM is less precise (for the determination of whether a 1 meter squared area is less than DCGLw) than hand-held instrumentation is to argue that one should "throw away" 95% of the data the SCM records and only use the data from 5 each 100 cm^2 areas. If one does this, then the SCM is less precise than hand-held instruments, since it only has 40 to 50 seconds of data left and hand-held still has 300 seconds. The correct way to obtain the average dpm/100cm^2 in a meter is to average the entire meter. With hand-held instrumentation, a simplified approximation is made that the readings across the meter are roughly equal and normally distributed and that one can sample only 5% of the meter to estimate what the true average would be.

The argument above does not take any credit for the "re-count" detector, which remeasures the same meter, and could be used to improve the precision by another factor of 1.4. SRA does not do this, since the SCM outperforms hand-held instrumentation for either DCGLw or DCGLemc measurements by such a large margin without the re-count detector considered.

Pixel	1	2	3	4	5	6	7	8	9	10
1	2853	2717	3034	3763	3849	4742	2557	4204	3333	2238
2	2587	3642	3409	5419	5733	2595	3385	2859	1478	1600
3	2631	3150	1592	3693	4755	3944	3685	2341	2159	793
4	7211	5462	3848	10009	7238	6619	7669	1615	4466	2825
5	8821	11083	14633	26768	14588	10360	10045	12012	4996	4767
6	7397	10424	5464	7761	8994	5996	10227	7061	6528	8265
7	11073	8541	13415	10972	13267	10113	7994	12864	19705	15404
8	5026	6710	7949	8502	9527	7882	5121	26814	66806	81175
9	6536	7719	6533	6417	13808	13840	19749	87994	186345	**210311**
10	9017	7946	11174	12528	20530	16083	19221	60104	102474	78481

Max	11073	11083	14633	26768	20530	16083	19749	87994	186345	**210311**

Mean: 15935.6 *

* Average of all 100 cm^2 Pixels in the Grid

The third spreadsheet provided uses the 21st row of pixels that was mentioned above. In order to calculate the maximum 100 cm^2 data, SIMS calculates the sum of any adjacent 4 pixels. The pixels on the top and left edge of the 4,2 square meter grid were included in the evaluation of the adjacent meter grids. The pixels in the 21st rows on the right and bottom edges are included in meter 4,2. This summation is shown in the spreadsheet labeled "2X2 Summing Filtered Data". It is interesting to compare the "Max" rows on the "2X2 Summing Filtered Data" and "100 cm^2 pixels" spreadsheets. This shows that alternate combinations of the 25 cm^2 data produce larger numbers, at times, than the simple sum of four used in the "100 cm^2 pixels" spreadsheet. This occurs because the peak contamination is often on the edge of a pixel, and the counts from it are spread equally into two or more pixels. While this does not have a large effect on the square meter (which is why we simply average the data), the data for 100 cm^2 does show larger changes depending on what four neighbor pixels are added together. By summing each pixel into the four combinations of nearest neighbor pixels, we assure that the maximum value is determined, just as a technician using a hand-held instrument moves it around when scanning and tries to find the location where the reading is a maximum. We are not trying to state what the average in the meter is, but rather state what the maximum would be. If you were to average this data (which SRA asserts is not correct), then the average could be slightly different, depending on the readings from the rows of pixels on the right and bottom. This effect is large for areas that have hot spots, and is small when the data is roughly constant across the area.

2x2 Summing Filtered Data

Pixel	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5
1.0	2853	3000	2717	2689	3034	3772	3763	4063	3849	3478	4742	3918	2557	3138	4204	4611	3333	1971	2238	1236
1.5	1871	1750	2797	2540	1952	3260	4213	3750	3766	3580	2859	3051	2931	2978	3341	2921	2643	1867	1856	2067
2.0	2587	3126	3642	3915	3409	4148	5419	5457	5733	3904	2595	3637	3385	2332	2859	2762	1478	1352	1600	1801
2.5	3365	4426	3899	3918	3149	3391	4676	5461	5996	4947	3637	3638	3381	2585	3102	2701	1335	726	1320	1038
3.0	2631	3688	3150	2904	1592	2908	3693	4228	4755	3936	3944	4220	3685	2617	2341	1771	2159	1433	793	526
3.5	5857	7521	3032	3297	2762	4697	8919	10018	8026	4994	5261	5796	4697	2199	535	1397	4727	6422	3092	0
4.0	7211	9955	5462	3310	3848	6054	10009	10574	7238	4466	6619	8234	7669	3821	1615	3821	4466	5085	2825	0
4.5	4302	6991	5916	5374	6449	11822	11822	9674	7523	2151	3766	4844	5381	5913	5911	4302	1076	0	537	537
5.0	8821	10968	11083	13897	14633	25105	26768	17762	14588	11058	10360	10604	10045	10363	12012	8201	4996	5333	4767	2315
5.5	10405	14140	15857	15995	12998	18109	22435	16642	14010	14244	13018	15396	14833	11401	11975	10317	8723	9060	6892	2843
6.0	7397	12160	10424	7958	5464	4399	7761	10227	8994	7761	5996	6893	10227	9862	7061	5128	6528	7929	8265	4566
6.5	6303	9454	5602	4202	5427	4902	6653	10679	10504	8228	8053	8403	11204	11380	7528	6653	11204	16807	15581	6653
7.0	11073	12115	8541	10124	13415	12227	10972	12500	13267	10920	10113	8975	7994	8942	12864	16554	19705	22551	15404	4507
7.5	11100	11309	8996	12276	16099	15230	12298	10129	11860	10454	7417	5017	4257	7445	18839	30138	31850	26213	19552	10346
8.0	5026	6324	6710	8191	7949	9086	8502	6825	9527	10107	7882	5116	5121	11557	26814	45863	66806	81756	81175	45372
8.5	4890	6746	7137	6387	5088	8106	8516	9127	11216	10654	9843	9114	11573	29739	51702	74285	141357	186259	174399	92975
9.0	6536	8485	7719	6377	6533	7591	6417	10100	13808	13323	13840	15666	19749	46506	87994	122474	186345	**228662**	210311	105298
9.5	8461	10486	8860	8645	9139	8861	7658	13728	19274	18107	17176	17596	20488	46610	88628	126285	167849	189245	163529	73052
10.0	9017	9629	7946	10055	11174	12009	12528	16335	20530	18570	16083	17997	19221	36247	60104	80422	102474	100757	78481	34795
10.5	8242	8758	7090	9614	13161	12274	10819	11528	17165	18040	13391	15512	16009	25766	36720	44459	43242	28466	27729	18001

Max	11100	14140	15857	15995	16099	25105	26768	17762	20530	18570	17176	17997	20488	46610	88628	126285	186345	**228662**	210311	105298

Attachment #1:

Dosing 11 Survey Report

81

Introduction

Survey Dosing11 was conducted on Tue Sep 19 15:12:36 1995 by DMD. Data was gathered using SRA Surface Contamination Monitor, 001The Position Sensitive Proportional Counter was operating with an efficiency of 12%. The SRA Survey Information Management System was used to provide visual imaging and analysis of the survey data and to generate this report.

Surface Activity Levels

The SCM measures and records activity in 25 cm^2 areas called pixels. Each square meter contains 400 individual pixels. These pixels can be summed into 100 cm^2 areas for comparison to release criteria. To evaluate the measured activity levels versus release criteria, consecutive 100 cm^2 sums are offset by 25 cm^2 pixels, thus ensuring that all possible 100 cm^2 combinations of the data are considered.

Total measured activity for Dosing11 ranged from 0 to 65,928 dpm/pixel. 100 cm^2 data ranged from 0 to 228,662 dpm/100 cm^2. An interpolated surface plot of the data is provided in Figure 1. A light source is simulated to add definition via shadows to the artifacts in the image.

Square Meter Data

Conventional statistics are provided by SIMS. The survey is divided into meter grids. For each grid the 100 cm^2 data is analyzed for mean, min, max, and standard deviation. The number of pixels containing data is also reported for each grid. Figure 2 shows the grid pattern, while Table 1 details the statistical data for each grid. Bold text denotes grids which exceed release limits.

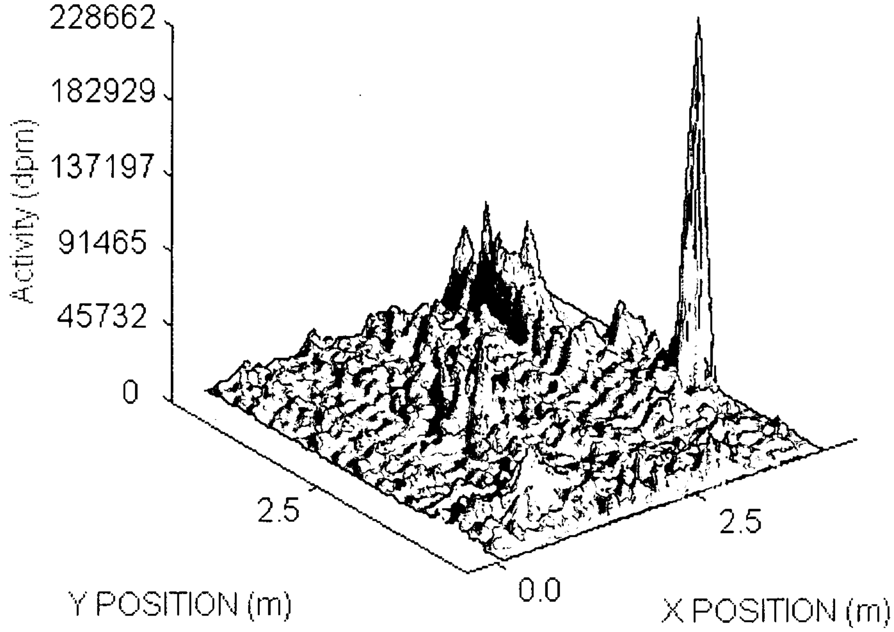


Figure 1 **Image plot of surface activity in dpm/25cm²**

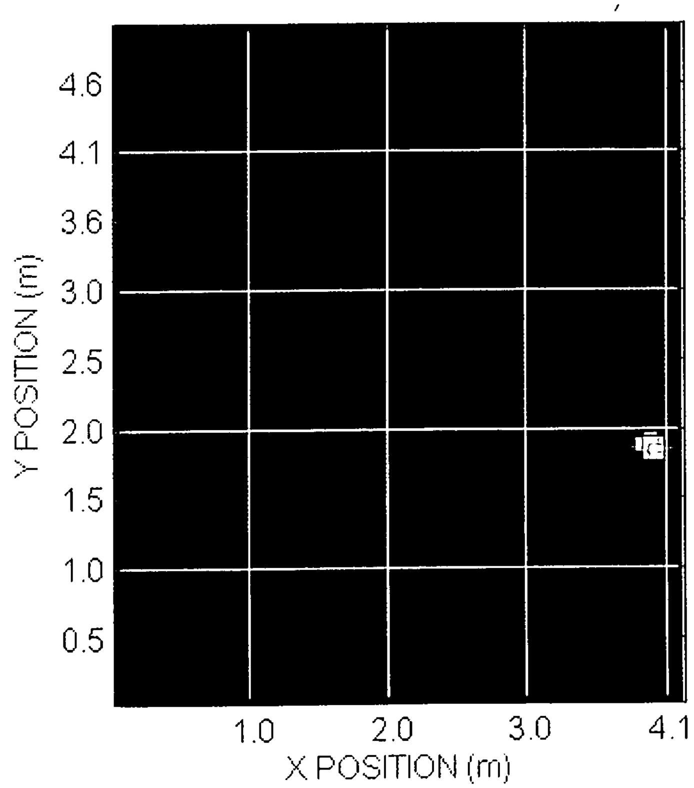


Figure 2 **Meter Grid overlaid onto dpm/25cm² image plot**

(Primary) Date: 05-21-1999 Time: 14:04:46 Dosing11-8

83

X	Y	Mean	Max	Min	STD	Pixels
1	**1**	**6,490**	**41,494**	**0**	**6461.0**	**90**
2	**1**	**6,251**	**31,372**	**0**	**5222.0**	**90**
3	**1**	**7,495**	**31,195**	**0**	**4680.0**	**90**
4	**1**	4,396	**17,008**	**0**	**2984.0**	**90**
5	1	N/A	N/A	N/A	N/A	0
1	2	3,859	**15,372**	**0**	**2787.0**	**100**
2	**2**	**5,846**	**17,260**	**1,389**	**2830.0**	**100**
3	2	4,440	13,794	291	2417.0	100
4	**2**	**15,935**	**228,662**	**793**	**31924.0**	**100**
5	2	N/A	N/A	N/A	N/A	0
1	3	2,876	11,623	0	1739.0	100
2	**3**	**8,827**	**60,568**	**551**	**7126.0**	**100**
3	**3**	**7,216**	**23,027**	**1,897**	**3260.0**	**100**
4	**3**	**12,706**	**30,992**	**4,391**	**5645.0**	**100**
5	3	N/A	N/A	N/A	N/A	0
1	4	3,093	9,021	0	1678.0	100
2	**4**	**7,244**	**26,954**	**1,944**	**4390.0**	**100**
3	**4**	**10,997**	**26,459**	**5,545**	**3437.0**	**100**
4	**4**	**13,989**	**56,389**	**0**	**13603.0**	**73**
5	4	N/A	N/A	N/A	N/A	0
1	5	4,485	12,965	0	2387.0	90
2	**5**	**6,188**	**16,938**	**2,034**	**2717.0**	**90**
3	**5**	**10,447**	**25,388**	**3,497**	**4672.0**	**90**
4	**5**	**16,576**	**77,483**	**0**	**16261.0**	**63**
5	5	N/A	N/A	N/A	N/A	0

Table 1 dpm/100cm^2 averaged over one square meter. Grids (1,1) - (5,1) and Grids (5,1) - (5,5) are not one square meter. Bold text denotes grids which exceed release limits

84

COMPARISON OF RESULTS WITH GUIDELINES

The survey data provided by the SRA Surface Contamination Monitor, serial number 001The limits for total activity were calculated by adding an observed background of 0 dpm/100 cm^2 to the survey criteria.

Criteria
5000 dpm/100 cm^2, averaged over $1m^2$
15000 dpm/100 cm^2, maximum in 100 cm^2

Total Activity Limits
5000 dpm/100 cm^2, averaged over $1m^2$
15000 dpm/100 cm^2, maximum in 100 cm^2

The survey results indicate that surface activity levels averaged over one square meter were above the site-specific guidelines for release in certain grid locations. The following grids are above the release limits: (1,1) (2,1) (3,1) (2,2) (4,2) (2,3) (3,3) (4,3) (2,4) (3,4) (4,4) (2,5) (3,5) (4,5)

The survey results indicate that the maximum surface activity levels in the 100 square centimeter zones were above the site-specific guidelines for release. Figure 3 details which zones were above release limits:

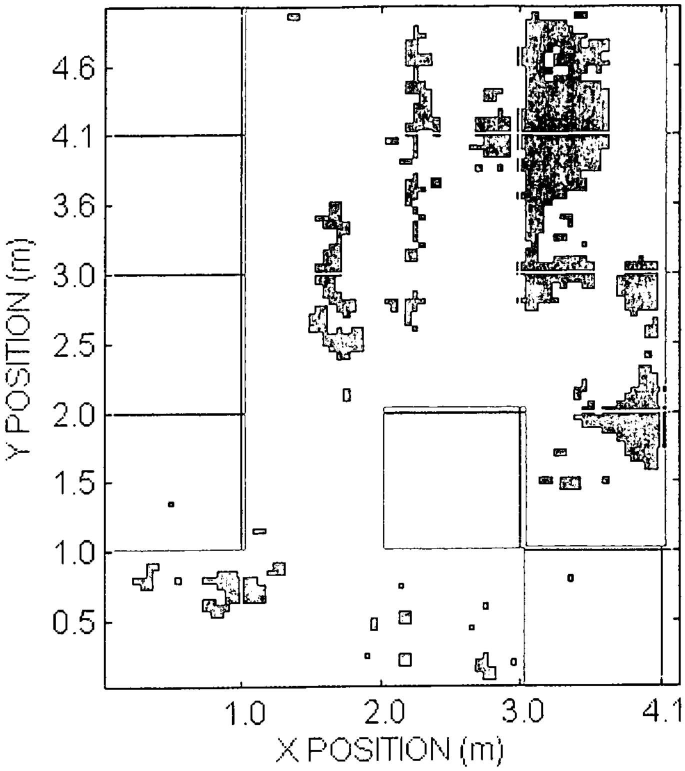


Figure 3 Yellow shading denotes grids in excess of the average limit, while red pixels correspond to the upper left coordinate of a 100cm^2 area exceeding the maximum limit.

(Primary) Date: 05-21-1999 Time: 14:04:46 Dosing11-11

86

Attachment 4

Evaluation of Surface Contamination Monitor/Survey Information Management (SCM/SIMS) for the identification of contamination against the $DCGL_{emc}$ for the 779 Closure Project at the Rocky Flats Environmental Technology Site

87

Evaluation of Surface Contamination Monitor/Survey Information Management (SCM/SIMS) for the identification of contamination against the $DCGL_{emc}$ for the 779 Closure Project at the Rocky Flats Environmental Technology Site

Introduction

The Surface Contamination Monitor/Survey Information Management System (SCM/SIMS) is performing surface contamination surveys at the 779 closure project at Rocky Flats Environmental Technology Site (RFETS). This evaluation of the SCM/SIMS is performed to determine the probability to detect localized contamination at the level of the $DCGL_{emc}$ as established for this project. The predominant isotope of concern is ^{239}Pu, and the $DCGL_{emc}$ is established as 300 dpm/100 cm^2. For completeness, additional discussion is provided relative to the performance of SCM/SIMS applicable to the $DCGL_w$, 100 dpm/100cm^2 average over 1 m^2.

This evaluation demonstrates that the SCM/SIMS system achieves the RFETS criterion for probability of detection for $DCGL_{emc}$ at a level below 130 dpm, nearly one third of the guideline level. This value is substantially below that attained with conventional hand-held instrumentation.

Acceptable Detection Probability for $DCGL_{emc}$

Previous evaluations performed at RFETS have referenced ANSI N13.12, "Surface Radioactivity Guides for Materials, Equipment, and Facilities to be Released for Uncontrolled Use" to establish acceptable levels for the detection of particles at the guideline values. This dictates that a 50% probability be used. The ANSI standard also forms the basis of historical regulatory requirements in this area for both DOE contractor and Nuclear Regulatory Commission licensee facilities. While a probability of 50% of "missing" low level contamination may seem high, surveys are performed multiple times in the release of facilities. This means that one-half of the particles are found in initial characterization, and one-half of the particles that remain are found in each subsequent survey. When characterization activities are completed, and no further particles are found, a final release survey is performed. At that time, the probability of having a particle present at the $DCGL_{emc}$ level is very low.

Discussion of SCM/SIMS

SCM/SIMS uses a Position Sensitive Proportional Counter (PSPC) to measure the amount and location of contamination present on a large surface. The PSPC detects radiation in the same manner as any proportional counter; that is, the physical principles of operation are the same for all proportional counters. As deployed at RFETS, the PSPC consists of a 180 cm or 90 cm long, 10 cm wide detector (active area). The location at which pulses were sensed by the PSPC from radioactive particles entering the detector can be determined. Data is "binned" in 5 cm increments along the length of the detector. This allows the long detector to act like a series of seamless 5 cm detectors. The counts are recorded in each 5 cm bin until the SCM has traveled a 5 cm distance as measured by a precision wheel encoder attached to the wheel. After 5 cm of travel, the data from each 5 cm bin is recorded and the bin is re-zeroed. The result is the mathematical creation of 25 cm^2 areas, called "pixels." To determine 100 cm^2 values, each pixel is considered to be 1/4th of four separate 100 cm2 areas. Each of the 400 separate 100 cm2 areas can then be evaluated to determine the maximum 100 cm2 area within a square meter, or against the $DCGL_{emc}$ to determine compliance. As is the case with hand-held instruments, the SCM/SIMS system is designed with a screen over the sensitive portion of the detector to reduce the frequency of tears in the mylar. The screen effectively reduces the response of the instrument by about 15%. This factor is accounted for during system calibration, since the screen equally affects response from a NIST traceable source as it would for contamination in the field.

A second, "recount" detector is used during alpha surveys due to the low background and low $DCGL_{emc}$'s. The short count time, for any one 100 cm^2 area will result in a small percentage of the areas indicating levels approaching the $DCGL_{emc}$'s when the counts detected are due to the statistical nature of background. Since 100% of an area is measured, the small percentage can result in several areas requiring follow-up investigation. The recount detector allows a user to examine the second survey to confirm or deny the finding from the primary detector. The practice, using a second detector to confirm if contamination is present or if the elevated counts are statistical fluctuations above background, is similar to the longstanding method of survey for alpha in which a user who surveys with a hand-held instrument momentarily pauses after hearing one or two "clicks" from the speaker to confirm the presence of radioactive material. If the elevated result is due to variations in background, the probability of both PSPC detectors being affected is very low (square root of the probability of a single detector). Thus, the use of a recount detector reduces the number of investigations due to background.

For either the SCM/SIMS or for conventional hand-held instrumentation, quantification is performed with a long count after the contamination is detected.

As with any survey instrument, the SCM efficiency is determined using an appropriate NIST traceable source. As is the practice in the nuclear field, a calibration source is used that distributes the radioactivity over a 100 square centimeter area, typically a square source that is 10 centimeters on a side. This area is used because the regulatory requirements are typically given in activity per 100 square centimeter area. A radiation detector will typically have a lower efficiency for distributed sources as compared to point-like sources because not all of the source material will be present under the detector. Thus, calibration with a distributed source can be thought of as "conservative" as the activity will either be correctly estimated from measurements or will be overestimated. The PSPC detectors have a 10 centimeter wide window. As the detector is scanned over a point source, activity is present for two of the 5 centimeter bins. Point sources are counted twice, once in each pixel. The results provide an overestimation of the actual contamination of an isolated point source. This approach is appropriate and is conservative, since use of a point source to establish efficiency would result in non-conservative (understated) assessments of distributed contamination. Contamination at the 779 closure project has typically been found to be particulate (localized particles). The "double counting" associated with small particles has resulted in the investigation level to be viewed as 112 dpm/100 cm2. Included as Attachments 1 and 2 are comparisons of

89

SCM/SIMS with conventional survey methods (i.e. Electra with DP6 probe) for several parameters critical to radiological surveys.

The present method of evaluating survey data against the $DCGL_{emc}$ is to evaluate all 100 cm^2 areas that exceed 225 dpm on either detector. This is done by evaluating each 25 square centimeter bin four times, with each combination of neighboring areas. The maximum value is chosen. If the average of the primary and recount for that area of the surface is greater than 225 dpm (which is 75% of the limit), an investigation with a longer count time is conducted. The investigations are normally performed with the NE Electra with a DP6 probe. However, the measurement could also be performed with the SCM (or any appropriate radiation detector) by placing the unit over the area of interest for a one-minute acquisition. During this one-minute acquisition, the activity level is determined with improved precision, (roughly a factor of 2.5 improvement in precision). This "more precise" measurement is not used to "find" the contamination, but simply used to confirm and quantify the contamination after it is found. During this fixed measurement, the "doubling" that occurs during a scan with the SCM is eliminated.

To determine the average number of counts recorded by the primary and recount detectors that would be equivalent to an average of 225 dpm, the following survey parameters apply:

Survey Speed	2 cm/sec (0.8 "/sec)
SCM efficiency	22%
Detector width	5 cm (per pixel)
Count time	2.5 sec (per pixel)

Therefore, 1 count in a pixel would be equivalent to:

$$1 \text{ count} = ((1/.22)/2.5 \text{ sec})*60 \text{ sec/min} = 109 \text{ dpm}$$

Therefore 2 counts in any combination of four adjoining pixels will be measured as 220 dpm. The averaging of the primary and recount detectors then requires that a total of 4 counts in both detectors will result in 220 dpm. These four counts can occur in any combination in the pixels that form the 100 cm^2 area. This value would not require further investigation. One additional count in either detector in the four adjoining pixels will result in a value for the average over 225 dpm and require investigation.

A particle of 300 dpm would be exposed to the 10 cm length of the detector for a total of 5 seconds with the detector travelling at a speed of 2 cm/sec. During the 5 second period, the counts expected from the particle would show a Poisson distribution with a mean of:

$$300 \text{ dpm}/60 \text{ sec/min} = 5 \text{ dps}$$

$$5 \text{ dps} * 0.22 = 1.1 \text{ cps}$$

$$1.1 \text{ cps} * 5 \text{ sec} = 5.5 \text{ counts.}$$

90

Two detectors, primary and recount, would have a total value of 11 counts (on average) due to a single 300 dpm particle. This occurs because of the double counting of the particle discussed above. The probability of detecting 300 dpm localized contamination with a mean of 11 counts totaled across both detectors (at $P > 5$) is calculated using the Poisson distribution. This is the same method as used in equation 6-14, page 6-49 of MARSSIM for the case of two counts, (rather than four counts that is used with the SCM/SIMS). The current practice at RFETS for surveys, whether with hand-held instrumentation or with the SCM is that all counts are treated as contamination. Thus, the background is "zero" for this analysis.

The number of 300 dpm particles that will not be detected can be easily calculated using the Microsoft Excel "Poisson" function, with the expected mean set at 11, and the number of events set to 4. The probability of 5 or more events (1 greater than the threshold) occurring is 98.49%. A graphical presentation of the probability of detecting localized particles of varying activity is also provided. The results indicate that localized contamination at the $DCGL_{emc}$ will be detected in excess of 98% of the time. As contamination increases, the probability of detection also increases. As can be seen from the graph, the 50% criterion is met at a level of 128 dpm.

Other Considerations

There are numerous factors that affect the ability of a human observer to "detect" radioactive contamination. These factors include the imprecise control of the measurement process by a human (e.g. scan speed, distance, overlap to assure complete coverage), physical impediments (15% chance that the protective screen impacts the stationary evaluation when the human "stops" to confirm the presence of contamination) and psychological factors (e.g. attentiveness during an extended survey, physical comfort needs, and the change in survey technique between the situation where the human believes contamination is present from that where the person believes that contamination is not present). All of these factors, called "human factors" can significantly affect the quality of a survey with hand-held instrumentation. MARSSIM recommends, based on literature studies, that a 50% factor be applied for "surveyor efficiency," which is an estimate for all but the psychological factors. The SCM/SIMS is not affected by any of these factors. This results in a more substantial benefit for the SCM/SIMS a compared to conventional methods in real world detection probability, compared to the benefits identified form a theoretical analysis such as this.

Conclusion

SCM/SIMS provides a survey method that will identify localized contamination at the $DCGL_{emc}$ greater than 98% of the time. This probability of detection exceeds the established standards. The design of the SCM provides additional assurances that survey parameter affected by human performance, such as scan speed, overlap, detector to surface distance and operator attentiveness are controlled to optimize performance of the survey.

Attachment 1

Comparison of Techniques Evaluating Against Average $DCGL_w$

Parameter	SCM/SIMS	Conventional: Electra w/DP6 Probe
# of 100 cm2/m2 Surveyed	100	5
Area Surveyed	100%	5%
Total Count Time	1000 Sec	300 Sec
Precision	1.83 X	1 X
Square Meter Averaging	Accurate (See Note 2)	See Note 3
Quality Checks	See Note 4	See Note 4
LLD	1 dpm/100 cm2	50 – 100 dpm/100 cm2
Other	Probability distribution functions, Spatial Analysis	Means & Tests
	Image Processing Tools	N/A
	Automatic Reporting	N/A

Note 1: The counting time is 3.33 times longer per square meter for the SCM versus the NE Electra. Thus, the precision is increased by a factor of $\sqrt{3.33} = 1.83$.

Note 2: SCM accuracy based on mathematical averaging of all data within the area. For example, assume 99 each, 100 cm^2 areas of 10 dpm and 1 area of 100 dpm are present in a given square meter. SCM will report average of 11 dpm. Conventional methods will report 10 dpm if the single area of 100 dpm is not included in the sampling of 5 areas. Conventional methods will report an average of 28 dpm, if the 100 dpm area is included in the 5 measurements.

Note 3: Requires non-parametric statistical test to determine distribution

Note 4: SCM uses an in field measurement of precision and accuracy pre & post each survey area. Conventional Methods use a pre survey measurement of reproducibility using a fixture and long count time to minimize uncertainties from other parameters, and an assumption of valid & accurate calibration.

Attachment 2

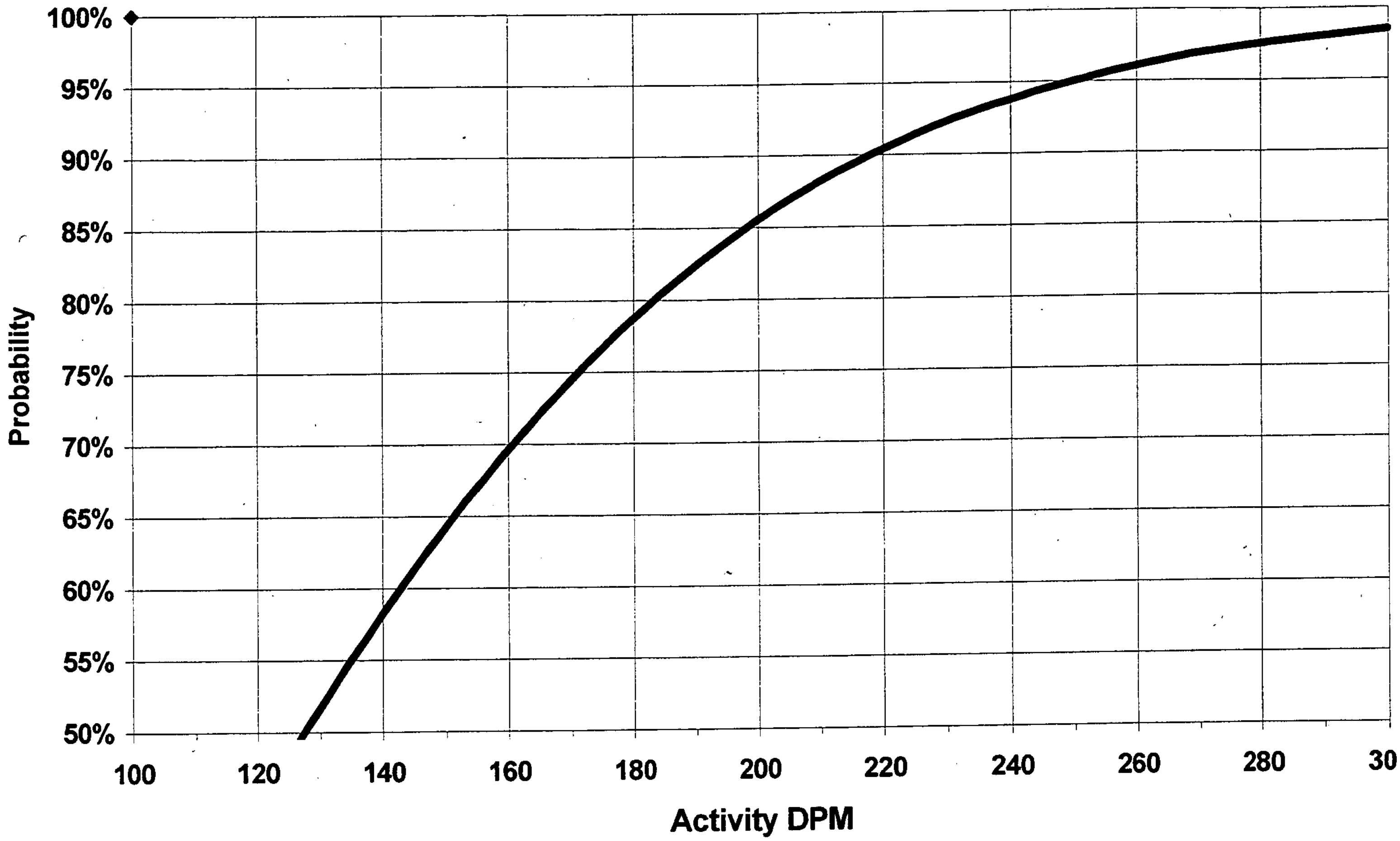
Comparison of Techniques Evaluating Against $DCGL_{emc}$

Parameter	SCM	Conventional: Electra w/ DP6 Probe
Speed	0.8"/sec	0.5"/sec
Speed control	+/- 10%	Human Factor
Source to detector Distance	0.5"	0.5"
Distance control	Instrument fixed	Human Factor
Documentation	Records, quantifies	Not recorded/assertion
LLD	Demonstrated finds at 100 dpm	300 dpm typical (See Note 1)
Area coverage	Area coverage	Human Factors
Screen impact	Moving screen does not mask alpha	See Note 2

Note 1: RCTs have hard time finding 150 dpm particles when detected by SCM

Note 2: Screen may mask alpha (15% of the time) when held stationary for 5 seconds following first "click"

SCM Detection Probability
(Average of 225 DPM = L_c)



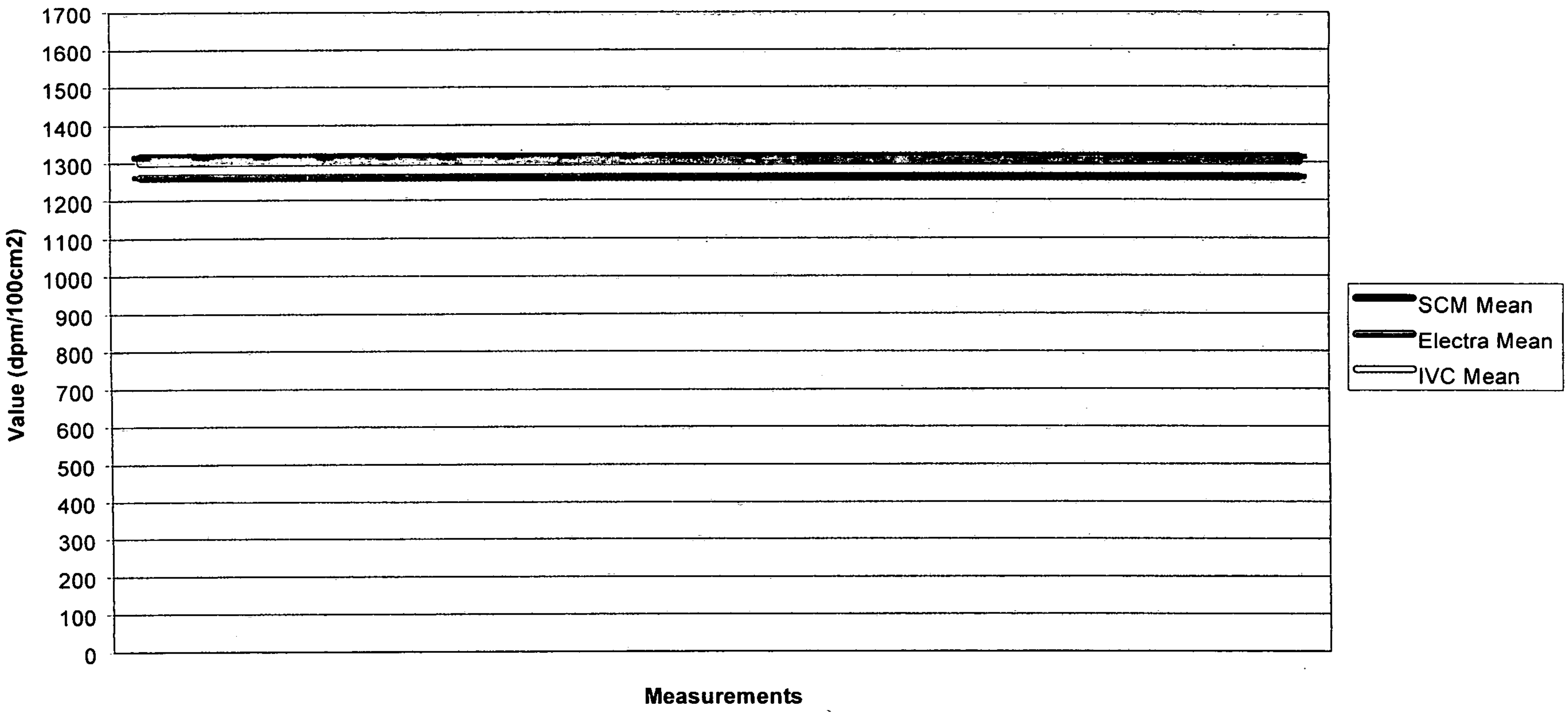
94

Attachment 5

Comparability of SCM vs. NE Electra vs. IVC Survey Instruments

95

SCM vs. NE Electra vs. IVC Data
(when exposed to a known activity Pu-239 Source)



SCM vs. NE Electra vs. IVC Data for Discrete 100 cm^2 Measurements (when exposed to Pu-239 source)

	SCM Results (dpm/100 cm^2)	NE Electra Results (dpm/100 cm^2)	IVC Results (dpm/100 cm^2)
	1381	1335	1440
	1118	1321	1321
	1536	1159	1344
	1185	1221	1235
	2106	1202	1291
	1281	1102	1330
	958	1283	1360
	1720	1306	1267
	1267	1311	1295
	1228	1335	1316
	1033	1316	1297
	1748	1354	1300
	1099	1278	1262
	1014	1121	1316
	1405	1202	1291
	1184	1397	1286
	1203	1349	1344
	1223	1178	1197
	1312	1211	1220
	1296	1240	1321
Avg =	***1315***	***1261***	***1302***
s =	280	83	53

97/97

Table A3-1. Building 729 FSS Compliance with MARSSIM Data Quality Guidelines

	MARSSIM sec 4.0	QAPP	SOPs	Training & Quals (personnel)	calibrations	QC Samples	sample quantities (adequacy of)	precision
Bldg 729 Final Status Survey Report								
Vol I Executive Summary								
sec 2.0 DCGLs								
sec 3.0 Background								
sec 4.0 Quality Control								
sec 5.0 Survey Results								
Appendices, Survey Drawings								
Appendices, Data Quality Assessment								X
Vol 2 Attachments								
Attach. A - D, Survey Results							X	
Vol 3 Attachments								
Attach. E, Source Certificate								
Attach. F, SCM/SIMS Invest. Results								
Attach. G, Final Survey Breakdown Struc.								
Attach. H - J, Survey Packages			X					
GENERAL								
Peer/Technical Reviews/Approvals								
Management Reviews/Approvals								
QA Reviews/Approvals								
Project File (Mike Grube)				X	X	X	X	
K-H Analytical Services, Archives in Bldg 881								
Independent Verification								
Bldg 729 Final Status Survey Plan		X						

	MARSSIM sec 8.2	Reviews - DQOs & Sampling Design	"prelim" data review	graphical data review	statistical tests & assumptions[1]	conclusions
Bldg 729 Final Status Survey Report						
Vol I Executive Summary						X
sec 2.0 DCGLs						
sec 3.0 Background						
sec 4.0 Quality Control						
sec 5.0 Survey Results						
Appendices, Survey Drawings				X		
Appendices, Data Quality Assessment		X				
Vol 2 Attachments						
Attach. A - D, Survey Results			X			
Vol 3 Attachments						
Attach. E, Source Certificate						
Attach. F, SCM/SIMS Invest. Results						
Attach. G, Final Survey Breakdown Struc.						
Attach. H - J, Survey Packages						
GENERAL						
Peer/Technical Reviews/Approvals		X	X	X		
Management Reviews/Approvals						
QA Reviews/Approvals		X	X			
Project File (Mike Grube)						
K-H Analytical Services, Archives in Bldg 881						
Independent Verification				X		X
Bldg 729 Final Status Survey Plan						

	MARSSIM sec 9.0	Reports (to decision makers)	site description	analytical methods & MDA/MDC	backgroud radiation	measurement results	Chain-of-Custody	SOPs	Quality records	results by geographic location	defined level of data review	data quality indicators (PARCCS)	QC measurements
Bldg 729 Final Status Survey Report		X											
Vol I Executive Summary													
sec 2.0 DCGLs													
sec 3.0 Background					X								
sec 4.0 Quality Control													
sec 5.0 Survey Results						X							
Appendices, Survey Drawings										X			
Appendices, Data Quality Assessment											X	X	
Vol 2 Attachments													
Attach. A - D, Survey Results									X				
Vol 3 Attachments													
Attach. E, Source Certificate									X				
Attach. F, SCM/SIMS Invest. Results						X	X		X				
Attach. G, Final Survey Breakdown Struc.													
Attach. H - J, Survey Packages				X				X					X
GENERAL													
Peer/Technical Reviews/Approvals													
Management Reviews/Approvals													
QA Reviews/Approvals													
Project File (Mike Grube)									X				
K-H Analytical Services, Archives in Bldg 881				X					X				
Independent Verification													
Bldg 729 Final Status Survey Plan			X										

	MARSSIM Appdx E (DQA)	review DQOs & survey design	"prelim" data review	select statistical test	verify assumptions (statistics)	draw conclusions
Bldg 729 Final Status Survey Report						X
Vol I Executive Summary						
sec 2.0 DCGLs						
sec 3.0 Background						
sec 4.0 Quality Control						
sec 5.0 Survey Results						
Appendices, Survey Drawings						
Appendices, Data Quality Assessment		X				
Vol 2 Attachments						
Attach. A - D, Survey Results			X			
Vol 3 Attachments						
Attach. E, Source Certificate						
Attach. F, SCM/SIMS Invest. Results						
Attach. G, Final Survey Breakdown Struc.						
Attach. H - J, Survey Packages						
GENERAL						
Peer/Technical Reviews/Approvals						
Management Reviews/Approvals						
QA Reviews/Approvals						
Project File (Mike Grube)						
K-H Analytical Services, Archives in Bldg 881						
Independent Verification		X				X
Bldg 729 Final Status Survey Plan						

	MARSSIM Appdx N	raw data; original data forms	QA assessments/NCRs/CARs	data reduction/calculations	method validation	historical data
Bldg 729 Final Status Survey Report						
Vol I Executive Summary						
sec 2.0 DCGLs						
sec 3.0 Background						
sec 4.0 Quality Control						
sec 5.0 Survey Results						
Appendices, Survey Drawings						
Appendices, Data Quality Assessment						
Vol 2 Attachments						
Attach. A - D, Survey Results						
Vol 3 Attachments						
Attach. E, Source Certificate						
Attach. F, SCM/SIMS Invest. Results						
Attach. G, Final Survey Breakdown Struc.						
Attach. H - J, Survey Packages						
GENERAL						
Peer/Technical Reviews/Approvals						
Management Reviews/Approvals						
QA Reviews/Approvals						
Project File (Mike Grube)		X		X		X
K-H Analytical Services, Archives in Bldg 881					X	
Independent Verification					X	
Bldg 729 Final Status Survey Plan						

[1]stippled boxes/areas are not applicable, based on consensus approval of the RCSP, which notes exceptions to MARSSIM statistical applications in decision-making.